roband

INSTRUCTION MANUAL

433

Roband Electronics Limited

MP MASTER
MA24166

SERIAL NUMBER _____

roband

INSTRUCTION MANUAL

433

OSCILLOSCOPE MAIN-FRAME TYPE RO70

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September, 1971

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1. SPECIFICATION

Cathode Ray Tube

Type	Mullard D14–160GH-09
Phosphor	P31 standard.
Display size	8cm x 10cm with internal parallax free variable illumination graticule.
E.H.T.	11KV approx.

Vertical Deflection System

Sensitivity	80mV/cm balanced at plug-in interface
Bandwidth	>90MHz when used with 7A1 plug-in

Horizontal Deflection System

Ramp Drive Sensitivity	0.6mA/cm at plug-in interface
External X Input	**Sensitivity:** 10mV/cm, 20mV/cm, 50mV/cm, and 100mV/cm. Variable extends range to 500mV/cm **Bandwidth:** DC to 2MHz, 10cm scan DC to 4MHz, 5cm scan When AC coupled, from 2Hz instead of DC **Input Impedance:** 1MΩ/15pF approx. BNC connector.
Magnifier	**Range:** expands centre portion of display 2X, 5X or 10X **Accuracy:** ±5% after first 4cm at 10ns/cm ±3% after first 2cm at 20ns/cm ±1% after first cm on all other ranges.

External "Z" input

Sensitivity	500mV P/P will produce noticeable modulation. 5V P/P will cause blanking under normal conditions.
Bandwidth	DC – 15MHz ±3dB.
Input Impedance	10KΩ 40pF approx. BNC connector 10Ω/40pF approx. BNC connector

Calibrator

Output Range	50μV – 20 volts in eighteen switched ranges
Accuracy	±2% (0°C – 50°C)
Max Output Current at 20V	6mA. Internally limited to 18mA into a short circuit.
Form	Square wave, ground to positive peak. Approx. 4μs rise and fall time.
Frequency	1KHz approx.

Power Requirements

Supply voltage	100V – 125V AC. } Selected by quick change voltage 200V – 250V AC. } selector located behind rear panel
Supply frequency	48 – 400Hz.
Power	120 watts max.

All power rails are electronically regulated, protected against current and reverse voltage overloads, and function normally with or without plug-in units fitted.

Environmental

Ambient Temperature Range	operating 0°C – 50°C non-operating – 30°C – +70°C The instrument may be operated standing on its rear cover but the maximum operating ambient temperature is reduced to +40°C.
Ventilation	Convection cooled.

Mechanical

Height	13.4″ (340mm)
Width	10.0″ (254mm) measured over maximum points.
Depth	20.5″ (463mm) Overall dimensions with plug-ins fitted may exceed this figure.
Weight	32 lb (14.5Kg) main frame only.

Construction

Frame	Aluminium alloy precision sand castings, acrylic texture finish.
Covers	Aluminium alloy, acrylic texture finish.
Camera Mounting	Standard 4½″ x 5″ centres on 10/32 UNF studs.

2. OPERATING INSTRUCTIONS

2.1 Function of Controls

GRAT & ON/OFF	The first few degrees of travel from the extreme anti-clockwise position switches the instrument ON. Advancing the control further increases the illumination of the internal graticule. The illuminated graticule is intended for photographic purposes only. Under normal ambient lighting conditions the graticule should not be illuminated and will appear as a dark line graticule.
BEAM LOCATE	Restricts the vertical deflection to less than 8cm thus bringing the display on screen under any overload condition.
INTENSITY	Controls the bias on the grid of the cathode ray tube and hence the brightness of the display. The INTENSITY control is a fine control which works in conjunction with the coarser INTENSITY RANGE control located behind the rear panel.
FOCUS	Enables a sharply defined trace to be obtained.
POSITION (VERNIER)	Controls the position of the display in the horizontal axis. The control has a 60° backlash action. The display should be moved slightly beyond the desired point and then accurately positioned using the much finer control provided by the backlash action.
MAGNIFIER	Selects both the signal source and the gain of the horizontal amplifier. With an internally generated sweep the central horizontal portion may be magnified by up to ten times. The external input can be either AC coupled or DC coupled by selecting the appropriate section of the MAGNIFIER, the sensitivity being determined by the magnification ratio.
EXT.VAR.	The EXT.VAR.control provides continuously adjustable gain settings between the MAGNIFIER steps for external signal inputs only.
CAL.OUTPUT	The amplitude calibrator provides a range of accurate amplitude signals for checking the calibration of the oscilloscope and also for adjusting the compensation of any probe being used.
mV–V Control	Attenuates the calibrator output by either X1 to give direct reading in volts, or by 1000 to give direct readings in mV.

2.2 General

Before operating the RO70, the setting of the mains selector should be checked and if necessary adjusted. The instrument is convection cooled and it is essential that none of the ventilation holes are obscured. In the event of the ventilation being impaired, an internal "thermal trip" will prevent the instrument being damaged by overheating.

2.3 Plug-in Units

Having selected suitable plug-in units, these should be inserted into the main frame. Pull out the appropriate release lever and push the plug-in unit into the main frame as far as it will go. Pushing the release lever to the closed position will now draw the plug-in home and lock it in position. Turn the INTENSITY control fully anticlockwise and switch the instrument "ON". Approximately 60 seconds should be allowed for the circuits to stabilise.

After this period, turn the POSITION control on the mainframe to the centre of its travel, depress the BEAM LOCATE button and advance the INTENSITY control until either a spot or line is obtained. Release the BEAM LOCATE button, should the spot or line disappear, the appropriate position control on the plug-in pre-amplifier should be adjusted to bring it back on-screen. To obtain a line the controls on the plug-in timebase should be set as outlined in the Operation Instruction section of the relevant handbook.

Refer to the Operating Instructions section of the appropriate plug-in unit manuals to proceed further.

3. CIRCUIT DESCRIPTION

The RO70 mainframe contains the power supplies including E.H.T. and all the output amplifiers necessary to drive the cathode ray tube.

A complete block diagram of the system is shown in Fig. 1. The unit consists of a printed circuit bulkhead board containing the interconnections and power circuits into which plug four other printed circuit boards. The complete circuit has been broken down into convenient sections and each circuit has a different component reference group. The circuit diagrams relate to the group numbers so that for example, R507 will be found on circuit diagram 5. The diagrams are listed below:

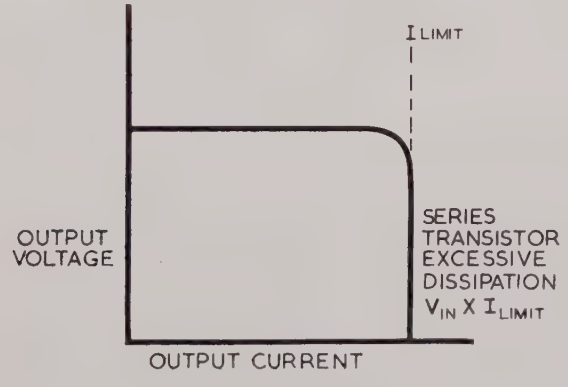
	Circuit	Group Reference
Power supply and distribution	1	100
Stabilisers	2	200
Cathode ray tube supplies	3	300
Vertical output amplifier	4	400
Horizontal output amplifier	5	500
Unblank amplifier	6	600
Calibrator	7	700
Vertical amplifier H.T. decoupling	8	800
Interconnections	0	000

3.1 Low Voltage Power Supplies (Circuits 1 and 2)

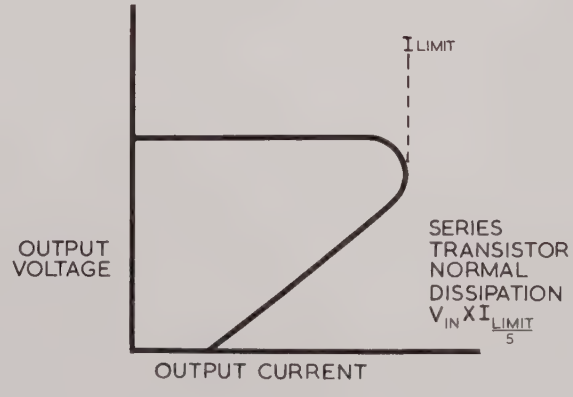
These are located at the rear of the instrument. The mains transformer, rectifiers and reservoir capacitors are mounted on the main bulkhead P.C.B. 90213. The raw D.C. is then regulated by series transistors located on the rear panel which are controlled by the feedback reference amplifiers on P.C.B. 90215. The control amplifiers all operate in a similar manner, a sensing circuit compares a sample of the output voltage against a fixed reference. Any error in the output voltage produces an error signal which is amplified, inverted and fed to the series transistors causing them to compensate for the error and return the voltage to normal.

Each of the five low voltage supplies has re-entrant current overload protection. In the event of an overload, the output voltage falls in order to maintain the output current within safe limits. However under short circuit conditions when the full unregulated supply voltage is developed across the series transistor, its power dissipation is reduced to a safe level by further restricting the output current to 10%–20% of the full load current.

The short circuit current is so adjusted that immediately upon removal of the overload the power supply will return to normal operation.



Constant Current Protection



Re-Entrant Protection.

The supplies are further protected by diodes against the accidental application of reverse voltage.

Mains Transformer

The mains transformer is fitted with a quick change supply voltage selector, which is located behind the rear panel.

−100V Supply

The −100V supply and the +80V supply control the calibration of the instrument. For this reason they are highly stabilised to maintain accuracy. The reference is provided by two temperature compensated zener diodes D285 and D286. The comparator stage TR281 compares this reference with a sample of the output voltage obtained from R291, R293, RV281 any error signal is amplified by TR282 and is used to control the series transistors TR283 and TR284.
Re-entrant current protection is provided by TR285.

−20V Supply

The comparator stage comprising TR261 and TR262 compares a sample of the output voltage obtained from RV261, R269, R270 against the reference supplied by D266. The error signal is used to control the series transistors TR263 and TR264 directly without any further amplification.
Re-entrant current protection is provided by TR265.

+20V Supply

The comparator stage comprising TR241 and TR242 compares a sample of the output voltage provided by R249, R251, RV241 against the reference obtained from D245. As with the−20V supply the error signal controls the series transistors TR243 and TR244 directly without any further amplification.
Re-entrant current protection is provided by TR245.

+80V Supply

The reference for this supply is obtained from two temperature compensated zener diodes D225 and D226. The supply for these diodes is taken from the +20V supply via R222 thus ensuring the collapse of the +80V supply should the +20V supply be removed; this is necessary to ensure that other circuits in the instrument are not damaged. The comparator stage TR221 compares the reference with a sample of the output voltage obtained from R231, R232, RV221, any error signal is amplified by TR222 and is used to control the series transistors TR223 and TR224. Re-entrant current protection is provided by TR225.

+135V Supply

The +135V supply is stabilised by comparing its output against the −100V supply. The error signal from the comparator TR201 is used to control the series transistors TR202, TR203 directly without any further amplification. The diode D205 limits the negative excursion of the junction R209, R210 in the event of the output being removed, thus protecting TR201 against excessive reverse V_{be}.
Diode D206 is also incorporated for safety reasons and ensures that if the +135V rail is shorted to a potential lower than +80 volts; the +80V supply will also collapse thus preventing damage to other circuits.

3.2 Cathode Ray Tube Supplies (Circuit 3)

The neck of the C.R.T. carries a trace rotation coil to align the horizontal axis with the internal graticule and an orthogonality coil to set the angle between the electrical axes to exactly 90°.

The high voltage and heater supplies required to operate the C.R.T. are derived from a feedback controlled D.C. to D.C. converter operating at approx. 50KHz. The high voltage section is contained in an encapsulated block thereby eliminating problems caused by high humidity.

The heater supply is obtained from a winding on T301 and the final anode voltage is provided by a voltage quadrupler comprising D306 – D309 and C308 – C311.

The power oscillator and control amplifier section is located on PCB 90214.

The push pull Class 'C' oscillator comprises TR301, TR302 and the primary of T301, feedback being obtained from a separate winding. The amplitude of oscillation and hence the output is controlled by varying the bias to the bases of the oscillator transistors.

A sample of the 1.65KV rail is compared with the +80V supply at the junction of R309, R324 Any error signal is amplified by the D.C. amplifier TR303, TR304, TR305 and varies the oscillator output such that the error is cancelled and the voltage returns to its correct value.

The +1.65KV stabilised supply is fed direct to the cathode of the C.R.T. The potential divider network R318 – R322, RV304 supplies the focus anode potential.

The cathode ray tube grid is connected to a separate floating supply of 1.7KV which is obtained from a secondary winding on T301, and D305, C304, C305 via the potential divider network RV302, R311 – R315. RV302 sets the range of the INTENSITY control.

The low frequency component of the unblank signal is coupled to the cathode ray tube grid via R329 and the 1.7KV supply. The high frequency component is coupled directly to the grid by C306.

3.3 Unblank Amplifier (Circuit 6)

The unblank amplifier supplies the fast rise large amplitude pulses required to cause the C.R.T. to conduct for the duration of each sweep. The unblank signal is superimposed on a D.C. level derived from the INTENSITY control.

The incoming signals are mixed at the low-impedance point provided by the emitter of the grounded-base amplifier TR601. When the horizontal amplifier is switched to EXT, a constant unblank signal is provided by a current fed through D600, R600 from PCB90216. Signals from the collector of TR601 are fed via a windowing diode D603 to the complementary output amplifier TR604, TR605, TR606 and TR607. In the event of the grounded base stage being fully cut-off D602 limits the maximum base-collector voltage of TR601 and D603 becomes reverse biased. The maximum positive excursion of the amplifier is then determined by the current flowing through R613, RV603 and is such that the amplifier will not saturate. Saturation in the negative direction is prevented by D601 and the clipping rail provided by TR602. Feedback is provided by R616 thus ensuring a very low output impedance. The diodes D604 and D605 protect the amplifier should an overload be inadvertently applied to the output lead. The mean beam current of the cathode ray tube is sensed by TR603. Should this current attempt to rise to a dangerously high level, TR603 conducts,thereby reducing the intensity of the display and protecting the cathode ray tube screen from damage.

3.4 Calibrator (Circuit 7)

The calibrator comprises a square wave generator with a level clipping output stage. The square wave is generated by the cross coupled multivibrator TR701, TR702. The disconnect diodes D703, D704 allow the output at the collectors of TR701 and TR702 to rise to the clipping level at a rate determined only by the stray capacitance.

The collector voltage of TR703 is set at 26V by D709, D708. Under overload conditions D708 reverse biases and the collector current is limited by R707. The base current which can be taken is limited

by RV701 and R706. The total emitter current under these conditions is limited to approximately 18mA.

The maximum positive excursion is adjusted by altering the current through the clipping diodes D706, D707 which offset the base-emitter volts drop of TR703.

The output from TR703 is applied to the potential divider network associated with S701. A further divide by 1000 attenuator can be switched in series with the output to give direct readings in mV.

3.5 Delay Line (Circuit 0)

A helically wound balanced delay line having a delay of 120ns and a characteristic impedance of 100Ω is connected between the mainframe input and the vertical output amplifier board. The input to the delay line is terminated on the bulkhead board (circuit 0) by R002, R004, R001, R003. The input signal excursion is limited at this point by D001 and D002. The output impedance of the cable is matched by the input impedance of the vertical output amplifier.

3.6 Vertical Output Amplifier (Circuit 4)

The vertical amplifier comprises a multistage balanced wide band amplifier with a cascode output configuration. The input stage is a balanced grounded base amplifier whose low input impedance together with R403, R404, provides the termination for the delay line. Current for trace separation when using the double timebase plug-in is applied via R408 and R409 at this point. The bias for the grounded base transistors is provided by TR401 which senses the level at the delay line output, thus always ensuring the correct bias.

The signals appearing at the collectors of TR402, TR403 are fed to TR404, TR405. Depressing the BEAM LOCATE button causes the normally reverse biased diodes D403, D404 to become forward conducting thus connecting together TR402 and TR403 collectors. This limits the signal excursion such that the display can never be deflected "off screen". The following two stages TR404, TR405, TR406 and TR407 are normal long-tailed pairs with compensation networks in the emitters to optimise the pulse response. The emitter followers TR408, TR409 provide a low impedance drive to the output stage. The transistors TR411, TR410, TR413, TR412 form a balanced cascode amplifier. The networks between the emitters of TR411 and TR412 set the current gain of the stage and provide compensation for setting the pulse response. The network R437, R447, R442 and RV408 is used to set the voltage gain of the stage.

The signals appearing at the collectors of TR410, TR413 are coupled by a low pass filter to the C.R.T. vertical deflector plates. Bias for the bases of TR410 and TR413 is obtained from the emitter follower TR414.

3.7 Horizontal Output Amplifier (Circuit 5)

The choice of signal source to the amplifier can be selected from the time base plug-in or the EXT INPUT amplifier. Correct termination is assured by the use of grounded-base stages which in turn drive a variable gain "windowing" amplifier. The output is taken from a complementary push-pull feedback controlled amplifier. The coupling and sensitivity of the EXT "X" input is selected by S501. The field effect transistor input stage is protected against overload by R502, C502 and D502. The potential at the output of TR502 is adjusted by RV504 such that adjusting the VARIABLE control RV503 does not affect the horizontal position.

The output from the timebase plug-in is selected by S501 and terminated in the grounded base stages TR503, TR504 by the terminating resistors R509, R516. Current from the POSITION control is also applied to the emitter of TR503. The emitter followers TR505, TR506, provide a low impedance drive to the "windowing" amplifier TR507, TR508. The gain of this amplifier and therefore the magnification is altered by varying the degree of emitter coupling. The output stage is current driven. Limiting the current available from TR507, TR508 by the long tails,R520, R521 ensures that the output stage is never allowed to saturate.

The deflector plate drive amplifier is a shunt feedback system comprising TR510 –TR517. The input signal and the MAG REG currents are summed at the virtual earth input of this amplifier.

The output pairs TR514, TR515 and TR516, TR517 being a complementary configuration are capable of providing the large current swings both positive going and negative going needed to charge the stray capacitance at high sweep speed. THE MAG REGISTRATION control provides a position offset independent of the magnifier setting to correct for any misalignment in the Cathode Ray Tube gun thus ensuring that the display is always magnified from the centre.

4. FAULTFINDING AND MAINTENANCE

The extensive use of plug and socket connections in the RO70 Oscilloscope facilitates rapid servicing. Certain components are specially selected from standard stock items and should only be replaced by similarly selected types obtainable from Roband. However in emergencies the standard item can be fitted but will probably result in a loss of performance.

Transistors can be damaged even by the momentary short caused by a slipping test prod or screwdriver, for this reason extreme care should be exercised when making measurements or adjustments.

4.1 Cathode Ray Tube

Extreme care should be exercised when removing and refitting the Cathode Ray Tube; an imploding tube can cause severe injuries and the use of protective goggles and gloves is highly recommended.

DANGER

THERE IS NO DISCHARGE PATH FOR THE +9.5KV SUPPLY.

The final anode connector should be removed with care and **both** the E.H.T. unit and the C.R.T. **immediately discharged.**

TABLE 1

Sympton	Check	Location	Effect	Action
Indicator light does	1a Supply			
not glow when	1b Mains tap on transformer.	Behind rear panel.		Correct if necessary.
switched on.	1c Mains fuse	Rear panel.		Replace if necessary.
	1d Thermal trip	Bulk head board.		Replace if open circuit.
No display	2a Increase INTENSITY	Front panel	Trace appears.	Proceed normally.
			Trace does not appear.	Proceed to 2b.
	2b Depress BEAM LOCATE button	Front panel	Trace appears	Readjust vertical position control, decrease sensitivity.
			Trace does not appear.	Proceed to 2c.
	2c Rotate horizontal POSITION control through its entire range still depressing the BEAM LOCATE button.	Front panel	Trace appears	Refer to timebase plug-in manual for correct operation.
			Trace does not appear.	Proceed to 2d.
	2d Remove amplifier plug-in.		Trace appears.	Refer to amplifier plug-in for correct operation.
			Trace does not appear.	Proceed to 2e.
	2e Remove timebase plug-in unit. Rotate horizontal POSITION control through its entire range.		Spot appears	Refer to plug-in handbook for probable defect.
			Spot does not appear.	Main frame defective.

4.2 Servicing

When the oscilloscope is suspected of being faulty, the checks listed in Table 1 should be carried out.

Having ascertained that the mainframe really is defective, switch off and visually inspect the instrument for loose connections, broken components, signs of overheating and any other obvious damage. Should any of these faults be found, it is essential that they be traced back to their source as quite frequently cause and effect are not the same component. A board found to contain any of these symptoms can be quickly isolated by removing the entire board. Having removed the defective board, or if none of the above symptoms have been found, the mainframe only should be switched on and the low voltage supplies checked.

Low Voltage Supplies

Should a defect be discovered on the stabilised board, all the other boards must be isolated before switching on the mainframe to check the supplies. The low voltage supplies are most easily checked on the stabiliser board P.C.B. 90215 where annotated test points will be found. If the voltages are correct proceed to the high voltage supplies, if not, check against the following table for the probable location of the defect.

TABLE 2

Supplies present					
−100V	−20V	+20V	+80V	+135V	Defective supply.
Yes	Yes	Yes	Yes	No	+135V
Yes	Yes	Yes	No	No	+ 80V
Yes	Yes	No	No	No	+ 20V
No	No	No	No	No	−100V
Yes	No	Yes	Yes	Yes	− 20V

A supply found to be considerably lower than normal should be checked for its resistance to ground with the instrument switched off and the results compared with the typical figures given in table 3.

TABLE 3

Supply	Resistance to Ground
+135V	2.7KΩ
+80V	860Ω
+20V	810Ω
−20V	1.2KΩ
−100V	6KΩ

A supply measuring low resistance or a short circuit should have the cause rectified. Again removing individual boards will help to isolate the defect.

An excessive load on any of the supplies can be readily checked by measuring the voltage developed across the over-current sensing resistors. The maxima are given in the following table.

TABLE 4.

Resistor	Voltage
R205	.75V
R228	1.2V
R247	1.0V
R265	1.4V
R289	.85V

Under normal operation the low frequency ripple will not exceed the following levels.

TABLE 5.

Supply	Ripple P/P
+135V	50mV
+80V	1mV
+20V	1mV
−20V	1mV
−100V	1mV

Cathode Ray Tube Supplies

Check the potentials at the following points:-
Vertical deflector plates: 50V ±3V. Any greater deviation will be the result of a defective vertical output amplifier.

Horizontal deflector plates: Adjust the horizontal POSITION control such that the potentials of the two plates are equal. This should be 50V ±10V. Any greater deviation will be the result of a defective horizontal output amplifier.

Cathode supply: −1,650V at pin 7 on the cathode ray tube base. A deviation of ±100V could be the result of incorrect adjustment. Greater than this, suspect a defective supply.

Floating supply: This should be adjusted by means of the INTENSITY control and if necessary the INTENSITY RANGE control to be 25V negative with respect to the cathode.

Having fulfilled the above conditions a spot should have appeared on the face of the cathode ray tube, if not, check the heater of the cathode ray tube visually and finally the +8,500V supply. This supply can only be measured by removing the final anode connector from the cone of the cathode ray tube. Remember that there is no discharge path and extreme caution should be exercised. If these checks are satisfactory and there is still no spot on the screen then the cathode ray tube is almost certainly defective.

High Voltage Supplies

The circuit is protected against sustained overload by FS301. Under normal operation the current will be 210mA ±20mA. Should this figure be exceeded then check that the −1,650V supply on pin 7 has been correctly set. Other causes of excessive current consumption; faulty oscillator transistors, faulty encapsulated unit. The latter is best checked by substitution with a known good unit.

High uncontrollable output, high ripple:

(a) check that the lead from pin 9 PCB.90214 to the encapsulated unit is sound.

(b) check TR305 and TR304 for collector-emitter shorts

Low output, excessive ripple:

(a) check for excessive external loading, remove the connections to pins 12, 13, 14, 15, 17 on the encapsulated unit and measure the current. If this exceeds 280mA then the encapsulated unit is almost certainly defective.

(b) check TR301 and TR302 for excessive collector-emitter leakage.

Vertical amplifier

Faults here fall into three general categories:-

Trace deflected off screen. These are readily detected by comparing the voltages with those shown on the circuit diagram.

Insufficient gain: Usually caused by faulty connections particularly to the cathode ray tube.

Poor pulse response. Usually caused by poor connections or faulty transistors.

Horizontal Amplifier

Faults here generally fall into three main categories:-

Trace deflected off screen. Compare voltages with those shown on the circuit diagram. Particular attention should be paid to the +125V and 50V supplies.

Insufficient gain, both internal and external. Check the connections to the magnifier switch S501. Low gain on external only, check RV505 for correct setting and then RV503 for high 'hop-on' resistance.

Poor linearity. Compare DC potentials with those shown on the circuit diagram. Poor linearity at high sweep speeds, adjust CV501 and CV502 as outlined in the calibration section.

5. CALIBRATION PROCEDURE

The instrument should always be recalibrated after servicing, and it is recommended that even though there have been no defects a complete recalibration be carried out yearly. This has the twofold advantage of assuring accuracy and providing useful preventive maintenance.

5.1 Equipment Required

(a) An accurate DC voltmeter ± 0.25% capable of measuring 1.7KV.
(b) An accurate AC voltmeter ±2% – ROBAND ROVAC.
(c) A variable auto-transformer.
(d) Test oscilloscope – ROBAND RO70 with suitable plug-ins.
(e) Test Standard 7A1 plug-in.
(f) Test Standard 7B1 plug-in.
(g) Current source 6mA ±0.5%
(h) Fast rise Pulse Generator with rise time <1ns and repetition rate variable from 1KHz to 100KHz.

5.2 Initial Set Up

Insert the 7A1 and 7B1 test standard plug-ins into the main frame and set the controls as follows.

Mainframe:-

FOCUS	mid range
INTENSITY	fully anticlockwise
Calibrator	.05
mV/V Switch	V
GRAT/ON-OFF	OFF
POSITION	mid range
MAGNIFIER	INT X1
EXT VAR	CAL

7A1 plug-in:-

VOLTS/cm	.05
VARIABLE	CAL
NORM/INV	NORM
POSITION	mid range
MODE	ALT triggered from A
AC GND DC	DC

7B1 plug-in:-

Trigger switches	all in the up position
TRIG LEVEL	mid range
Mode	ALT in normal mode
DELAY MULT	fully anticlockwise
TIME/cm	100μs
TRACE SEP	to give a satisfactory display.
B SWEEP INTENSITY	

5.3 Low Voltage Supplies

With the mains supply at nominal, switch on the supply to the instrument and using the accurate D.C. voltmeter set the outputs of the –100V, +80V, +20V, –20V rails in that order. The +135V rail should now be within 5V of nominal. Using the test oscilloscope, check that the ripple levels do not exceed the limits of Table 6.

Now reduce the supply 10% below nominal and check that all the rails remain within the limits of Table 6.

TABLE 6.

Supply	Max change	Max ripple
−100V	± 500mV	1mV
− 20V	± 200mV	1mV
+ 20V	± 200mV	1mV
+ 80V	± 400mV	1mV
+ 135V	± 1V*	50mV

*A maximum change of ±1V is allowable in addition to the ±5V variation at mains nominal.

Return the mains supply to nominal voltage.

5.4 High Voltage Supplies

With the mains supply at nominal and using the accurate DC voltmeter, set the −1,650V supply on pin 7 of the cathode ray tube base to be correct.

Reduce the mains supply 10% and check that this voltage does not vary by more than 4V.

Advance the INTENSITY control approximately 30° and adjust the INTENSITY RANGE control on the rear panel such that the spot is just visible.

5.5 Cathode Ray Tube Supplies

Apply the 200mV output from the CALIBRATOR to 'A' channel input socket and obtain a triggered display. Adjust the FOCUS and ASTIG controls for a sharp display. Check, and if necessary, adjust the ROTATION control on PCB.90216 such that the trace is aligned along the horizontal axis of the graticule. Now adjust the ORTHOG control also on PCB.90216 such that the verticals also align with verticals of the graticule. These two controls interact and the above steps should be repeated until the axes are at right angles.

The GEOM 2 control located on PCB.90211 should initially be set to mid range and GEOM 1 on PCB.90214 adjusted to give straight verticals at the edge of the display. Turning GEOM 2 control anticlockwise will reduce the background illumination but introduce some pincushion distortion which can be corrected by a further adjustment of the GEOM 1 control. By suitable adjustment of the two controls the best compromise between background illumination and geometry can be obtained.

5.6 Amplitude Calibrator

Connect the accurate DC voltmeter between pins 3 and 4 on PCB.90211. Now ground the junction of R705 and D705 and adjust the CAL ADJ control for a reading of 20V. Removing the ground link should cause the reading to fall to 10V ± 500mV, indicating the correct mark to space ratio.

5.7 Horizontal Amplifier

Remove the timebase plug-in.

Adjust the horizontal POSITION control such that the potentials on pins 29 and 30 on PCB.90216 are equal. Now adjust the X VOLTS control on PCB.90216 such that this potential is 50V.

Apply the accurate 6mA signal between pins 12 and 13 on PCB.90216 and adjust the X1 gain control to give a display of exactly 10cm. Remove the signal.

Whilst switching the MAGNIFIER switch between INT X1 and INT X10 adjust the POSITION control such that there is no horizontal movement of the spot. Having obtained the required setting of the POSITION control, switch the MAGNIFIER switch to INT X1 and adjust the MAG REGISTRATION control RV511 to position the spot on the central vertical graticule line. Without altering the setting of the POSITION control, switch the MAGNIFIER to EXT DC X10 and adjust the EXT BAL control to re-centre the spot.

Connect a coaxial jumper lead between the CAL OUT socket and the EXT INPUT. Set the CALIBRATOR switch to 1V, the MAGNIFIER to EXT DC X1 and the external VARIABLE control RV303 to CAL. Now adjust the EXT GAIN control to place the two spots exactly 10cm apart. Remove the coaxial lead.

Insert the Test Standard 7B1 plug-in into the mainframe and set the controls as follows

Trigger switches	all in the up position.
TRIG LEVEL	mid range.
MODE	A in normal mode
DELAY MULTIPLIER	anticlockwise
TIME/cm	1ms/cm

Return the CALIBRATOR switch to the 200mV position, apply the output to 'A' channel input and obtain a locked display.

With the MAGNIFIER in the INT X1 positon, adjust the VARIABLE TIME/cm control to give a display of exactly 10 cycles, i.e. each positive edge is coincident with a vertical graticule line.

Turn the MAGNIFIER to INT X2 and adjust the X2 control to give exactly five complete cyles, i.e. one cycle per 2cm.

Turn the MAGNIFIER to INT X5 and adjust the X5 control to give positive edges coincident with the 0cm, 5cm and 10cm verticals.

Turn the MAGNIFIER to INT X10 and adjust the X10 control to give positive edges coincident with the 0cm and 10cm verticals.

Feed a suitable 100MHz signal into the amplifier, set the TIME/cm control to .1cm/μs MAGNIFIER INT. X10), the VAR control to CAL and obtain a locked display. Now adjust CV501 and CV502 for optimum accuracy and linearity.

5.8 Vertical Amplifier

With the 200mV signal from the Calibrator still applied to 'B' channel input, adjust RV408 to give exactly 4cm of display height.

Apply the output of the Fast Rise Square pulse Generator to 'B' channel input using the correct cable and termination. Select a pulse repetition frequency as indicated with an output of 200mV, and obtain a locked display.

The following controls should be adjusted to obtain a horizontal top to the pulse, each control affects a specific area and by adjusting in the sequence given the effect will move back towards the leading edge of the pulse.

Control	Recommended PRF.
RV407	1KHz
RV404	10KHz
RV402	100KHz
RV403	100KHz

In the following adjustments set the variable capacitor such that the sharpest corner is obtained without any overshoot, then adjust the variable resistor to bring this part horizontal.

CV404 – RV406.
CV403 – RV405.
CV401 – RV401.

Now adjust CV402 to obtain the sharpest corner on the top of the leading edge. It will probably be necessary to repeat all these steps several times to obtain a good pulse response without any ringing or overpeaking.

The bandwidth should now be checked and if necessary the above steps repeated.

6. PARTS LIST

C101	100µ	−20% +50%	275V	ELECTROLYTIC	05−52−136
C104	100n	10%	250V	POLYESTER	05−48−036
C121	500µ	−20% +50%	150V	ELECTROLYTIC	05 52 060
C125	8µ	−20% +50%	150V	ELECTROLYTIC	05−52−014
C141	2m5	−10% +50%	40V	ELECTROLYTIC	05−52−084
C144	20µ	−10% +50%	64V	ELECTROLYTIC	05−52 027
C161	2m5	−10% +50%	40V	ELECTROLYTIC	05 52−084
C164	20µ	−10% +50%	64V	ELECTROLYTIC	05−52−027
C181	500µ	−20% +50%	150V	ELECTROLYTIC	05 52 060
C184	8µ	−20% +50%	150V	ELECTROLYTIC	05−52−014
C202	8µ	−20% +50%	150V	ELECTROLYTIC	05−52−014
C203	100n	10%	250V	POLYESTER	05−48−036
C222	12µ	−10% +50%	25V	ELECTROLYTIC	05−52−021
C223	10n	10%	250V	POLYESTER	05−48−006
C224	20µ	−10% +50%	64V	ELECTROLYTIC	05−52−027
C242	12µ5	−10% +50%	25V	ELECTROLYTIC	05−52−021
C243	220n	10%	100V	POLYCARBONATE	05−48−022
C262	220n	10%	100V	POLYCARBONATE	05−48−022
C263	12µ5	−10% +50%	25V	ELECTROLYTIC	05−52−021
C282	12µ5	−10% +50%	25V	ELECTROLYTIC	05−52−021
C283	10n	10%	250V	POLYESTER	05−48−006
C284	12µ5	−10% +50%	25V	ELECTROLYTIC	05−52−021
C300	400µ	−10% +50%	40V	ELECTROLYTIC	05−52−057
C301	400µ	−10% +50%	40V	ELECTROLYTIC	05−52−057
C302	220n	10%	100V	POLYCARBONATE	05−48−022
C303	100n	10%	250V	POLYESTER	05−48−036
C304	10n	GMV	2KV	CERAMIC	05−47−052
C305	10n	GMV	2KV	CERAMIC	05−47−052
C306	10n	GMV	2KV	CERAMIC	05−47−052
C308	1n	−20% +50%	8KV	CERAMIC	05−47−067
C309	1n	−20% +50%	8KV	CERAMIC	05−47−067
C310	1n	−20% +50%	8KV	CERAMIC	05−47−067
C311	1n	−20% +50%	8KV	CERAMIC	05−47−067
C312	10n	GMV	2KV	CERAMIC	05−47−052
C313	10n	GMV	2KV	CERAMIC	05−47−052
C314	10n	GMV	2KV	CERAMIC	05−47−052
C315	10n	GMV	2KV	CERAMIC	05−47−052
C316	10n	GMV	2KV	CERAMIC	05−47−052
C317	10n	GMV	2KV	CERAMIC	05−47−052
C318	100n	10%	250V	POLYESTER	05−48−036
C319	100n	10%	250V	POLYESTER	05−48−036
C320	5n	−25% +50%	500V	CERAMIC	05−47−049
C321	100n	10%	250V	POLYESTER	05−48−036
C322	1n	−25% +50%	750V	CERAMIC	05−47−041
C401	22p	10%	500V	CERAMIC	05−47−014
C402	22p	10%	500V	CERAMIC	05−47−014
C403	2n	−25% +50%	750V	CERAMIC	05−47−043
C404	2n	−25% +50%	750V	CERAMIC	05−47−043
C405	6p8	10%	750V	CERAMIC	05−47−063
C406	47p	5%	500V	CERAMIC	05−47−070
C407	12p	10%	500V	CERAMIC	05−47−071
C408	1n	5%	25V	POLYSTYRENE	05−48−039
C409	5p6	10%	750V	CERAMIC	05−47−007
C410	10n	10%	250V	POLYESTER	05−48−006
C414	1n	−25% +50%	750V	CERAMIC	05−47−041
C501	100n	10%	250V	POLYESTER	05−48−036
C502	5n	−25% +50%	500V	CERAMIC	05−47−049

C503	12µ5	−10% +50%	25V	ELECTROLYTIC	05−52 -021
C504	12µ5	−10% +50%	25V	ELECTROLYTIC	05−52 -021
C505	1n	−25% +50%	750V	CERAMIC	05−47−041
C506	1n	−25% +50%	750V	CERAMIC	05−47−041
C507	100p	10%	500V	CERAMIC	05−47 -068
C508	100p	10%	500V	CERAMIC	05−47−068
C509	5n	−25% +50%	500V	CERAMIC	05−47−048
C510	5n	−25% +50%	500V	CERAMIC	05−47−048
C511	100n	10%	250V	POLYESTER	05−48−036
C512	100n	10%	250V	POLYESTER	05−48−036
C513	470n	10%	250V	POLYESTER	05−48−035
C514	12µ5	−10% +50%	25V	ELECTROLYTIC	05−52−021
C515	12µ5	−10% +50%	25V	ELECTROLYTIC	05−52−021
C516	470n	10%	250V	POLYESTER	05−48 -035
C517	100n	10%	250V	POLYESTER	05−48 -036
C518	1n	−25% +50%	750V	CERAMIC	05−47−041
C519	100n	10%	250V	POLYESTER	05−48−036
C520	12µ5	−10% +50%	25V	ELECTROLYTIC	05−52−021
C521	1n	−25% +50%	750V	CERAMIC	05−47−041
C522	1n	−25% +50%	750V	CERAMIC	05−47−041
C601	220n	10%	100V	POLYESTER	05−48−022
C602	220n	10%	100V	POLYESTER	05−48−022
C603	5µ	−10% +50%	64V	ELECTROLYTIC	05−52−011
C604	100n	10%	100V	POLYESTER	05−48−036
C605	1n	−25% +50%	750V	CERAMIC	05−47−041
C606	220n	10%	100V	POLYESTER	05−48−022
C607	2n	−25% +50%	750V	CERAMIC	05−47−043
C608	1n	−25% +50%	750V	CERAMIC	05−47−041
C701	4n7	5%	100V	POLYESTER	05−48−041
C702	4n7	5%	100V	POLYESTER	05−48−041
C703	5n	−25% +50%	500V	CERAMIC	05−47−049
C704	12µ5	−10% +50%	25V	ELECTROLYTIC	05−51−021
C705	1n	10%	400V	POLYESTER	05−48−002
C706	47p	10%	500V	CERAMIC	05−47−070
C801	2n	−25% +50%	750V	CERAMIC	05−47−043
C802	2n	−25% +50%	750V	CERAMIC	05−47−043
C803	2n	−25% +50%	750V	CERAMIC	05−47−043
C804	2n	−25% +50%	750V	CERAMIC	05−47−043
C805	1n	−25% +50%	750V	CERAMIC	05−47−041

CAPACITORS VARIABLE

CV401	3p−9p	−10% +50%	160V	05−49−011
CV402	3p−9p	−10% +50%	160V	05−49−011
CV403	4p5−20p	−10% +70%	160V	05−49−015
CV404	3p−9p	−10% +50%	160V	05−49−011
CV501	p25−1p5			05−49−012
CV502	p25−1p5			05−49−012

DIODES

D001	10V	30mA	CAY 11	10−82−103
D002	10V	30mA	CAY 11	10−82−103
D101	200V	1A	IN 4003	10−82−040
D102	200V	1A	IN 4003	10−82−040
D103	200V	1A	IN 4003	10−82−040
D104	200V	1A	IN 4003	10−82−040

D121		200V	1A		IN 4003	10–82–040
D122		200V	1A		IN 4003	10–82–040
D123		200V	1A		IN 4003	10–82–040
D124		200V	1A		IN 4003	10–82–040
D141		200V	1A		IN 4003	10–82–040
D142		200V	1A		IN 4003	10–82–040
D143		200V	1A		IN 4003	10–82–040
D144		200V	1A		IN 4003	10–82–040
D161		200V	1A		IN 4003	10–82–040
D162		200V	1A		IN 4003	10–82–040
D163		200V	1A		IN 4003	10–82–040
D164		200V	1A		IN 4003	10–82–040
D181		200V	1A		IN 4003	10–82–040
D182		200V	1A		IN 4003	10–82–040
D183		200V	1A		IN 4003	10–82–040
D184		200V	1A		IN 4003	10–82–040
D205		75V	225mA		IN 916	10–82–024
D206		200V	1A		IN 4003	10–82–040
D225	ZENER	6V2		400mW	IN 821	10–81–007
D226	ZENER	6V2		400mW	IN 821	10–81–007
D227	ZENER	30V		500mW	IN 5256	10–81–059
D228		200V	1A		IN 4003	10–82–040
D245	ZENER	5V1		400mW	IN 5231B	10–81–030
D246		200V	1A		IN 4003	10–82–040
D247		75V	225mA		IN 916	10–82–024
D265		200V	1A		IN 4003	10–82–040
D266	ZENER	5V1		400mW	IN 5231B	10–81–030
D267		75V	225mA		IN 916	10–82–024
D285	ZENER	6V2		400mW	IN 821	10–81–007
D286	ZENER	6V2		400mW	IN 821	10–81–007
D287		75V	225mA		IN 916	10–82–024
D288	ZENER	5V1		400mW	IN 5231B	10–81–030
D289		200V	1A		IN 4003	10–82–040
D301		75V	225mA		IN 916	10–82–024
D303		150V	250mA		OA 202	10–82–048
D304	ZENER	3V3		400mW	ZF 3.3	10–81–012
D305		5KV	50mA		5AV50	10–82–106
D306		5KV	50mA		5AV50	10–82–106
D307		5KV	50mA	M	5AV50	10–82–106
D308		5KV	50mA		5AV50	10–82–106
D309		5KV	50mA		5AV50	10–82–106
D310		5KV	50mA		5AV50	10–82–106
D401	ZENER	8V2	(2% selected at 10mA)		ZF 8.2	
D402	ZENER	8V2			ZF 8.2	
D403		75V	225mA		IN 916	10–82–024
D404		75V	225mA		IN 916	10–82–024
D405		75V	225mA		IN 916	10–82–024
D501	ZENER	5V1		400mW	IN 5231B	10–81–030
D502		75V	225mA		IN 916	10–82–024
D503		75V	225mA		IN 916	10–82–024
D504		75V	225mA		IN 916	10–82–024
D505		75V	225mA		IN 916	10–82–024
D506		75V	225mA		IN 916	10–82–024
D507		150V	250mA		OA 202	10–82–048
D600		75V	225mA		IN 916	10–82–024
D601		75V	225mA		IN 916	10–82–024
D602		75V	225mA		IN 916	10–82–024
D603		75V	225mA		IN 916	10–82–024
D604		75V	225mA		IN 916	10–82–024
D605		75V	225mA		IN 916	10–82–024

D701		75V	225mA	IN 916	10–82–024
D702		75V	225mA	IN 916	10–82–024
D703		75V	225mA	IN 916	10–82–024
D704		75V	225mA	IN 916	10–82–024
D705		75V	225mA	IN 916	10–82–024
D706		75V	225mA	IN 916	10–82–024
D707		75V	225mA	IN 916	10–82–024
D708		75V	225mA	IN 916	10–82–024
D709	ZENER	5V1	400mW	ZF 5.1	10–81–030

DELAY LINE

DELAY LINE	ROBAND	B 9059

E. H. T. UNIT

E. H. T. UNIT	ROBAND	9058EL

FUSES

FS 101	Size 0	ANTISURGE	1A	01–01–024
FS 102	THERMAL FUSE 68°C			01–01–087
FS 301	Size 00	ANTISURGE	500mA	01–01–016
FUSE HOLDER	Size 0	For FS 101		01–00–014

INDUCTORS

L401	ROBAND	80130/6
L402	ROBAND	80130/6
L403	ROBAND	80130/9
L404	ROBAND	80130/9
L501	ROBAND	80130/1
L502	ROBAND	80130/1
L503	ROBAND	80130/10
L504	ROBAND	80130/10
L601	ROBAND	80130/7
L602	ROBAND	80130/7
L603	ROBAND	80130/7
L701	ROBAND	80130/14
L702	ROBAND	80130/7
L703	ROBAND	80130/14
L801	ROBAND	80130/7
L802	ROBAND	80130/7
L803	ROBAND	80130/7
L804	ROBAND	80130/7
L805	ROBAND	80130/7
L806	ROBAND	80130/7
L807	ROBAND	80130/7
L808	ROBAND	80130/7
L809	ROBAND	80130/7

LAMPS

LP 101	18V	1W	01–08–014
LP 102	18V	1W	01–08–014
LP 103	18V	1W	01–08–014
LP 104	18V	1W	01–08–014
LP 105	110V	NEON WITH HOLDER	01–09–008

ALL TOLERANCES 5% UNLESS QUOTED

R001	27R	1%	250mW	OXIDE	12–44–066
R002	27R	1%	250mW	OXIDE	12–44 066
R003	10R	1%	250mW	OXIDE	12–44 090
R004	10R	1%	250mW	OXIDE	12–44 090
R100	120K		500mW	OXIDE	04–45–219
R101	27K		500mW	OXIDE	04–45 144
R102	100K		500mW	OXIDE	04–45–175
R103	100K		500mW	OXIDE	04–45–175
R121	27K		500mW	OXIDE	04–45–144
R141	2K2		500mW	OXIDE	04–45 090
R161	2K2		500mW	OXIDE	04–45–090
R181	33K		500mW	OXIDE	04–45–148
R202	4K7		500mW	OXIDE	04–45–107
R203	5K6		500mW	OXIDE	04–45–111
R204	3K9		2W	OXIDE	04–46–282
R205	10R		1W	OXIDE	04–46–001
R206	820R		500mW	OXIDE	04–45–068
R207	270R		500mW	OXIDE	04–45–051
R208	68K		500mW	OXIDE	04–45–167
R209	51K		500mW	OXIDE	04–45–235
R210	39K		500mW	OXIDE	04–45–152
R222	1K1		500mW	OXIDE	04–45–075
R223	1K5		500mW	OXIDE	04–45–080
R224	27K		1W	OXIDE	04–46–139
R225	47K		500mW	OXIDE	04–45–158
R226	47R		500mW	OXIDE	04–45–026
R227	10K		500mW	OXIDE	04–45–121
R228	2R2	10%	3W	WIREWOUND	12–94–023
R229	820R		500mW	OXIDE	04–45–068
R230	12K		1W	OXIDE	04–46–115
R231	12K		1W	OXIDE	04–46–115
R232	2K1	1%	250mW	METAL FILM	12–44–103
R233	47K		500mW	OXIDE	04–45–158
R242	2K7		500mW	OXIDE	04–45–095
R243	390R		500mW	OXIDE	04–45–056
R244	330R		500mW	OXIDE	04–45–054
R245	10K		500mW	OXIDE	04–45–121
R246	47R		500mW	OXIDE	04–45 -026
R247	1R5	10%	3W	WIREWOUND	12–94–018
R248	470R		500mW	OXIDE	04–45–059
R249	1K5		500mW	OXIDE	04–45–080
R250	8K2		500mW	OXIDE	04–45–116
R251	470R		500mW	OXIDE	04–45–059
R262	1K2		500mW	OXIDE	04–45–077
R263	13K		500mW	OXIDE	04–45–129
R264	47R		500mW	OXIDE	04–45–026
R265	2R2	10%	3W	WIREWOUND	12–94–023
R266	680R		500mW	OXIDE	04–45–066
R267	8K2		500mW	OXIDE	04–45–116
R268	390R		500mW	OXIDE	04–45–056
R269	470R		500mW	OXIDE	04–45–059
R270	1K5		500mW	OXIDE	04–45–080
R271	2K7		500mW	OXIDE	04–45–095
R282	1K5		500mW	OXIDE	04–45–080
R283	12K		1W	OXIDE	04–46–115
R284	22K		1W	OXIDE	04–46–131
R285	43K		500mW	OXIDE	04–45–155
R286	47R		500mW	OXIDE	04–45–026

R287	15K		500mW	OXIDE	04–45–132
R288	10K		1W	OXIDE	04–46–111
R289	3R3		3W	WIREWOUND	12–94–026
R290	820R		500mW	OXIDE	04–45–068
R291	2K1	1%	250mW	METAL FILM	12–44–103
R292	47K		500mW	OXIDE	04–45–158
R293	15K		1W	OXIDE	04–46–120
R300	3R3		6W	WIREWOUND	12–94–027
R301	3R3		6W	WIREWOUND	12–94–027
R304	820R		1W	OXIDE	04–46–054
R305	10K		500mW	OXIDE	04–45–121
R306	270K		500mW	OXIDE	04–45–186
R307	470K		500mW	OXIDE	04–45–195
R308	2K2		500mW	OXIDE	04–45–090
R309	910K		500mW	OXIDE	04–45–202
R310	4K7		500mW	OXIDE	04–45–107
R311	6M8		500mW	CARBON	04–46–266
R312	6M8		500mW	CARBON	04–46–266
R313	6M8		500mW	CARBON	04–46–266
R314	6M8		500mW	CARBON	04–46–266
R315	6M8		500mW	CARBON	04–46–266
R316	470K		500mW	OXIDE	04–45–195
R317	470K		500mW	OXIDE	04–45–195
R318	3M3		500mW	CARBON	04–46–258
R319	3M3		500mW	CARBON	04–46–258
R320	3M3		500mW	CARBON	04–46–258
R321	2M2		500mW	CARBON	04–46–254
R322	2M7		500mW	CARBON	04–46–283
R323	10K		500mW	OXIDE	04–45–121
R324	20M		500mW	OXIDE	04–46–263
R329	10K		500mW	OXIDE	04–45–121
R330	1M		500mW	OXIDE	04–45–204
R331	18K		500mW	OXIDE	04–45–137
R332	47K		500mW	OXIDE	04–45–158
R333	5K6		500mW	OXIDE	04–45–111
R334	18K		500mW	OXIDE	04–45–137
R335	56K		500mW	OXIDE	04–45–214
R336	27K		500mW	OXIDE	04–45–144
R337	100K		500mW	OXIDE	04–45–175
R401	5K6	1%	250mW	OXIDE	12–44–087
R402	5K6	1%	250mW	OXIDE	12–44–087
R403	47R	1%	250mW	OXIDE	12–44–093
R404	47R	1%	250mW	OXIDE	12–44–093
R405	1K		250mW	OXIDE	04–45–072
R406	6K8	1%	1W	OXIDE	12–44–106
R407	6K8	1%	1W	OXIDE	12–44–106
R408	5K6		250mW	OXIDE	04–45–110
R409	5K6		250mW	OXIDE	04–45–110
R410	150R	1%	250mW	OXIDE	12–44–094
R411	150R	1%	250mW	OXIDE	12–44–094
R412	47K		250mW	OXIDE	04–45–157
R413	820R		250mW	OXIDE	04–45–067
R414	510R	1%	500mW	OXIDE	12–44–108
R415	270R	1%	250W	OXIDE	12–44–095
R416	1K8	1%	1W	OXIDE	12–44–109
R417	1K8	1%	1W	OXIDE	12–44–109
R418	270R	1%	250mW	OXIDE	12–44–095
R419	220R	1%	250mW	OXIDE	12–44–082
R420	100R		250mW	OXIDE	04–45–035
R421	10K		250mW	OXIDE	04–45–120

R422	150R	1%	250mW	OXIDE	12 -44–094
R423	270R	1%	250mW	OXIDE	12–44–095
R424	1K5	1%	1W	OXIDE	12–44–110
R425	1K5	1%	1W	OXIDE	12–44–110
R426	270R	1%	250mW	OXIDE	12 44–095
R427	150R	1%	250mW	OXIDE	12–44–094
R428	2K7		250mW	OXIDE	04–45–094
R430	680R		500mW	OXIDE	04–46–052
R431	680R		500mW	OXIDE	04–46–052
R432	100R		250mW	OXIDE	04–45–035
R433	100R		250mW	OXIDE	04–45–035
R434	75R		3W	WIREWOUND	12–94–184
R435	300R 5% }	0.5% MATCH	3W	THICK FILM)	12 -44–116
R436	300R 5% }		3W	THICK FILM)	ONE ITEM ONLY
R437	33R		250mW	OXIDE	04–45–019
R438	220R	1%	1W	OXIDE	12–44–111
R439	220R	1%	1W	OXIDE	12–44–111
R440	220R	1%	1W	OXIDE	12–44–111
R441	220R	1%	1W	OXIDE	12–44–111
R442	33R		250mW	OXIDE	04–45 -019
R443	120R	1%	1W	OXIDE	12–44–112
R444	56R		250mW	OXIDE	04–45–029
R445	1K8		250mW	OXIDE	04–45–083
R446	12K		250mW	OXIDE	04–45–126
R447	220R		250mW	OXIDE	04–45–012
R448	22R		250mW	OXIDE	04–45–012
R449	22R		250mW	OXIDE	04–45–012
R450	10K		500mW	OXIDE	04–45–121
R451	3K3		250mW	OXIDE	04–45–098
R452	56K	1%	500mW	OXIDE	12–44–113
R453	24K	1%	500mW	OXIDE	12–44–114
R454	6K8		250mW	OXIDE	04–45–113
R455	47R		250mW	OXIDE	04–45–025
R456	47R		250mW	OXIDE	04–45–025
R457	33R		250mW	OXIDE	04–45–019
R458	33R		250mW	OXIDE	04–45–019
R459	22R		250mW	OXIDE	04–45–012
R460	22R		250mW	OXIDE	04–45–012
R501	1M		500mW	OXIDE	04–45–204
R502	100K		500mW	OXIDE	04–45–175
R503	4K7		500mW	OXIDE	04–45–107
R504	100R		500mW	OXIDE	04–45–036
R505	100R		500mW	OXIDE	04–45–036
R506	8K2		500mW	OXIDE	04–45–116
R507	68R		500mW	OXIDE	04–45–033
R508	3K9		500mW	OXIDE	04–45–102
R509	47R		500mW	OXIDE	04–45–026
R510	13K		500mW	OXIDE	04–45–129
R511	1M		500mW	OXIDE	04–45–204
R512	1K1		500mW	OXIDE	04–45–075
R513	39K		1W	OXIDE	04–46–149
R514	15K		1W	OXIDE	04–46–120
R515	1K1		500mW	OXIDE	04–45–075
R516	47R		500mW	OXIDE	04–45–026
R517	1K8		500mW	OXIDE	04–45–084
R518	1K8		500mW	OXIDE	04–45–084
R519	100R		500mW	OXIDE	04–45–036
R520	30K		1W	OXIDE	04–46–142
R521	30K		1W	OXIDE	04–46–142
R522	3K9		500mW	OXIDE	04–45–102

R523	3K9		500mW	OXIDE	04–45–102
R524	1K		500mW	OXIDE	04–45–073
R525	470R		500mW	OXIDE	04–45–059
R526	180R		500mW	OXIDE	04–45–234
R527	82R		500mW	OXIDE	04–45–028
R528	5K6		500mW	OXIDE	04–45–111
R529	10K		500mW	OXIDE	04–45–121
R530	22R		500mW	OXIDE	04–45–013
R531	1K6		500mW	OXIDE	04–45–081
R532	18K		500mW	OXIDE	04–45–137
R533	18K		500mW	OXIDE	04–45–137
R534	22R		500mW	OXIDE	04–45–013
R535	1K6		500mW	OXIDE	04–45–081
R536	620R		500mW	OXIDE	04–45–054
R537	620R		500mW	OXIDE	04–45–054
R538	68R		500mW	OXIDE	04–45–033
R539	18K		500mW	OXIDE	04–45–137
R540	33K		500mW	OXIDE	04–45–148
R541	33K		500mW	OXIDE	04–45–148
R542	18K		500mW	OXIDE	04–45–137
R543	68R		500mW	OXIDE	04–45–033
R544	390R		500mW	OXIDE	04–45–056
R545	3K9		1W	OXIDE	04–46–085
R546	390R		500mW	OXIDE	04–45–056
R547	3K9		1W	OXIDE	04–46–085
R548	100K		500mW	OXIDE	04–45–175
R549	100K		500mW	OXIDE	04–45–175
R550	100R		500mW	OXIDE	04–45–036
R551	13K		1W	OXIDE	04–46–119
R552	13K		1W	OXIDE	04–46–119
R554	4K7		500mW	OXIDE	04–45–107
R555	100K		500mW	OXIDE	04–45–175
R556	100R		500mW	OXIDE	04–45–036
R557	10R		500mW	OXIDE	04–45–222
R600	12K		250mW	OXIDE	04–45–126
R601	47R		250mW	OXIDE	04–45–025
R602	47R		250mW	OXIDE	04–45–025
R603	10K		250mW	OXIDE	04–45–120
R604	15K		250mW	OXIDE	04–45–131
R605	3K	1%	500mW	OXIDE	12–44–127
R606	24K		1W	OXIDE	04–46–136
R607	820R		250mW	OXIDE	04–45–067
R608	10K		250mW	OXIDE	04–45–120
R609	15K		250mW	OXIDE	04–45–131
R610	4K7		250mW	OXIDE	04–45–106
R611	10K		250mW	OXIDE	04–45–120
R612	5K6		250mW	OXIDE	04–45–110
R613	39K		500mW	OXIDE	04–45–152
R614	3K3		250mW	OXIDE	04–45–098
R615	8K2		500mW	OXIDE	04–45–116
R616	18K		500mW	OXIDE	04–45–137
R617	2K2		250mW	OXIDE	04–45–089
R618	15K		250mW	OXIDE	04–45–131
R619	22K		1W	OXIDE	04–46–131
R620	330R		250mW	OXIDE	04–45–053
R701	15K		500mW	OXIDE	04–45–132
R702	470K		500mW	OXIDE	04–45–195
R703	390K		500mW	OXIDE	04–45–194
R704	390K		500mW	OXIDE	04–45–194
R705	470K		500mW	OXIDE	04–45–195

R706	12K		500mW	OXIDE	04-45-127
R707	10K		500mW	OXIDE	04-45-121
R708	10K		250mW	OXIDE	04-45-120
R709	10K		250mW	OXIDE	04-45-120
R711	1K978	0.5%	125mW	METAL FILM	12-44-117
R712	1K014	0.5%	125mW	METAL FILM	12-44-118
R713	606R7	0.5%	125mW	METAL FILM	12-44-119
R714	201R2	0.5%	125mW	METAL FILM	12-44-120
R715	100R4	0.5%	125mW	METAL FILM	12-44-121
R716	60R	0.5%	125mW	METAL FILM	12-44-122
R717	20R	0.5%	125mW	METAL FILM	12-44-123
R718	10R	0.5%	125mW	METAL FILM	12-44-124
R719	10R	0.5%	125mW	METAL FILM	12-44-124
R720	99K90	0.5%	125mW	METAL FILM	12-44-125
R721	100R	0.5%	125mW	METAL FILM	12-44-126
R722	56R		500mW	OXIDE	04-45-027

POTENTIOMETERS

RV101	10K with OFF/ON	20%	1W	MOULDED CARBON	12-96-048
RV221	220R	20%	250mW	CARBON	12-96-002
RV241	100R	20%	250mW	CARBON	12-96-037
RV261	100R	20%	250mW	CARBON	12-96-037
RV281	220R	20%	250mW	CARBON	12-96-002
RV301	100K	20%	250mW	CARBON	12-96-035
RV302	2M	20%	1W	MOULDED CARBON	12-96-046
RV303	10K	20%	250mW	MOULDED CARBON	12-96-042
RV304	2M	20%	1W	MOULDED CARBON	12-96-045
RV305	10K	20%	250mW	CARBON	12-96-042
RV306	47K	20%	250mW	CARBON	12-96-043
RV308	22K	20%	250mW	CARBON	12-96-019
RV309	220K	20%	250mW	CARBON	12-96-044
RV401	100R	10%	500mW	CERMET	12-96-056
RV402	5K	10%	500mW	CERMET	12-96-055
RV403	1K	10%	500mW	CERMET	12-96-054
RV404	5K	10%	500mW	CERMET	12-96-055
RV405	50R	20%	500mW	CERMET	12-96-052
RV406	200R	10%	500mW	CERMET	12-96-053
RV407	5K	10%	500mW	CERMET	12-96-055
RV408	1K	10%	500mW	CERMET	12-96-054
RV501	100K	20%	2W	CONCENTRIC	12-98-031
RV502	100K	20%	2W	MOULDED CARBON	
RV503	1K	20%	250mW	MOULDED CARBON	12-96-049
RV504	1K	20%	250mW	CARBON	12-96-039
RV505	47R	20%	250mW	CARBON	12-96-036
RV506	22K	20%	250mW	CARBON	12-96-019
RV507	470R	20%	250mW	CARBON	12-96-006
RV508	470R	20%	250mW	CARBON	12-96-006
RV509	220R	20%	250mW	CARBON	12-96-002
RV510	100R	20%	250mW	CARBON	12-96-037
RV511	2K2	20%	250mW	CARBON	12-96-012
RV601	4K7	20%	2W	MOULDED CARBON	12-96-047
RV602	1K	20%	250mW	CARBON	12-96-039
RV603	4K7	20%	250mW	CARBON	12-96-140
RV701	10K	20%	250mW	MOULDED CARBON	12-96-042

SWITCHES

S101	MAINS SWITCH	MOUNTED ON RV101	
S102	BEAM LOCATE	PUSH BUTTON	05–43–056
S501	MAGNIFIER	ROTARY	05–43–055
S701 S702	CALIBRATOR	ROTARY CONCENTRIC	05–43–049

TRANSISTORS

TR101	P.N.P.		2N 4036	10–85–054
TR201	N.P.N.		2N 3440	10–85–043
TR202	N.P.N.		2N 3440	10–85–043
TR203	N.P.N.		2N 3583	10–85–095
TR204	N.P.N.		BC 107	10–85–009
TR221	N.P.N.	DUAL	2C 444	10–85–030
TR222	N.P.N.		BFW 45	10–85–086
TR223	N.P.N.		2N 3440	10–85–043
TR224	N.P.N.		2N 3442	10–85–044
TR225	N.P.N.		BC 107	10–85–009
TR241	N.P.N.		BC 107	10–85–009
TR242	N.P.N.		BC 107	10–85–009
TR243	N.P.N.		BC 107	10–85–009
TR244	N.P.N.		2N 3055	10–85–041
TR245	N.P.N.		BC 107	10–85–009
TR261	N.P.N.		BC 107	10–85–009
TR262	N.P.N.		BC 107	10–85–009
TR263	N.P.N.		BC 107	10–85–009
TR264	N.P.N.		2N 3055	10–85–041
TR265	N.P.N.		BC 107	10–85–009
TR281	N.P.N.	DUAL	2C 444	10–85–030
TR282	N.P.N.		BC 107	10–85–009
TR283	N.P.N.		2N 3440	10–85–043
TR284	N.P.N.		2N 3442	10–85–044
TR285	N.P.N.		BC 107	10–85–009
TR301	N.P.N.		2N 3440	10–85–043
TR302	N.P.N.		2N 3440	10–85–043
TR303	P.N.P.		BCY 71	10–85–081
TR304	N.P.N.		BC 107	10–85–009
TR305	P.N.P.		2N 4036	10–85–054
TR306	N.P.N.		2N 3053	10–85–039
TR307	N.P.N.		2N 3053	10–85–039
TR401	N.P.N.		BC 107	10–85–009
TR402	P.N.P.		MPS 3640	10–85–098
TR403	P.N.P.		MPS 3640	10–85–098
TR404	N.P.N.		BFY 90	10–85–016
TR405	N.P.N.		BFY 90	10–85–016
TR406	N.P.N.		BFY 90	10–85–016
TR407	N.P.N.		BFY 90	10–85–016
TR408	N.P.N.		BFW 30	10–85–085
TR409	N.P.N.		BFW 30	10–85–085
TR410	N.P.N.		2N 3866	10–85–096
TR411	N.P.N.		2N 5109	10–85–097
TR412	N.P.N.		2N 5109	10–85–097
TR413	N.P.N.		2N 3866	10–85–096
TR414	P.N.P.		BCY 71	10–85–081
TR501	N. CHANNEL FET		BFW 11	10–85–088
TR502	N.P.N.		BC 107	10–85–009
TR503	N.P.N.		BC 107	10–85–009
TR504	N.P.N.		BC 107	10–85–009

TR505	N.P.N.	BFX 89	10-85-099
TR506	N.P.N.	BFX 89	10-85-099
TR507	N.P.N.	BFW 45	10-85-086
TR508	N.P.N.	BFW 45	10-85-086
TR509	N.P.N.	BC 109C	10-85-087
TR510	N.P.N.	BFW 45	10-85-086
TR511	N.P.N.	BFW 45	10-85-086
TR512	N.P.N.	BC 107	10-85-009
TR513	N.P.N.	BC 107	10-85-009
TR514	P.N.P.	BFW 44	10-85-092
TR515	N.P.N.	BD 115	10-85-089
TR516	N.P.N.	BD 115	10-85-089
TR517	P.N.P.	BFW 44	10-85-092
TR518	P.N.P.	BFW 44	10-85-092
TR601	P.N.P.	BCY 71A	10-85-082
TR602	P.N.P.	BCY 71	10-85-081
TR603	P.N.P.	BCY 71	10-85-081
TR604	N.P.N.	BFX 89	10-85-099
TR605	P.N.P.	BCY 71A	10-85-082
TR606	N.P.N.	BC 107B	10-85-009
TR607	N.P.N.	BC 107B	10-85-009
TR701	N.P.N.	BC 107	10-85-009
TR702	N.P.N.	BC 107	10-85-009
TR703	N.P.N.	BC 107	10-85-009

TRANSFORMERS

T101		ROBAND	AW 5756
T301		ROBAND	80023

CATHODE RAY TUBE

V301	D14/160GH/09	MULLARD	01-08-041

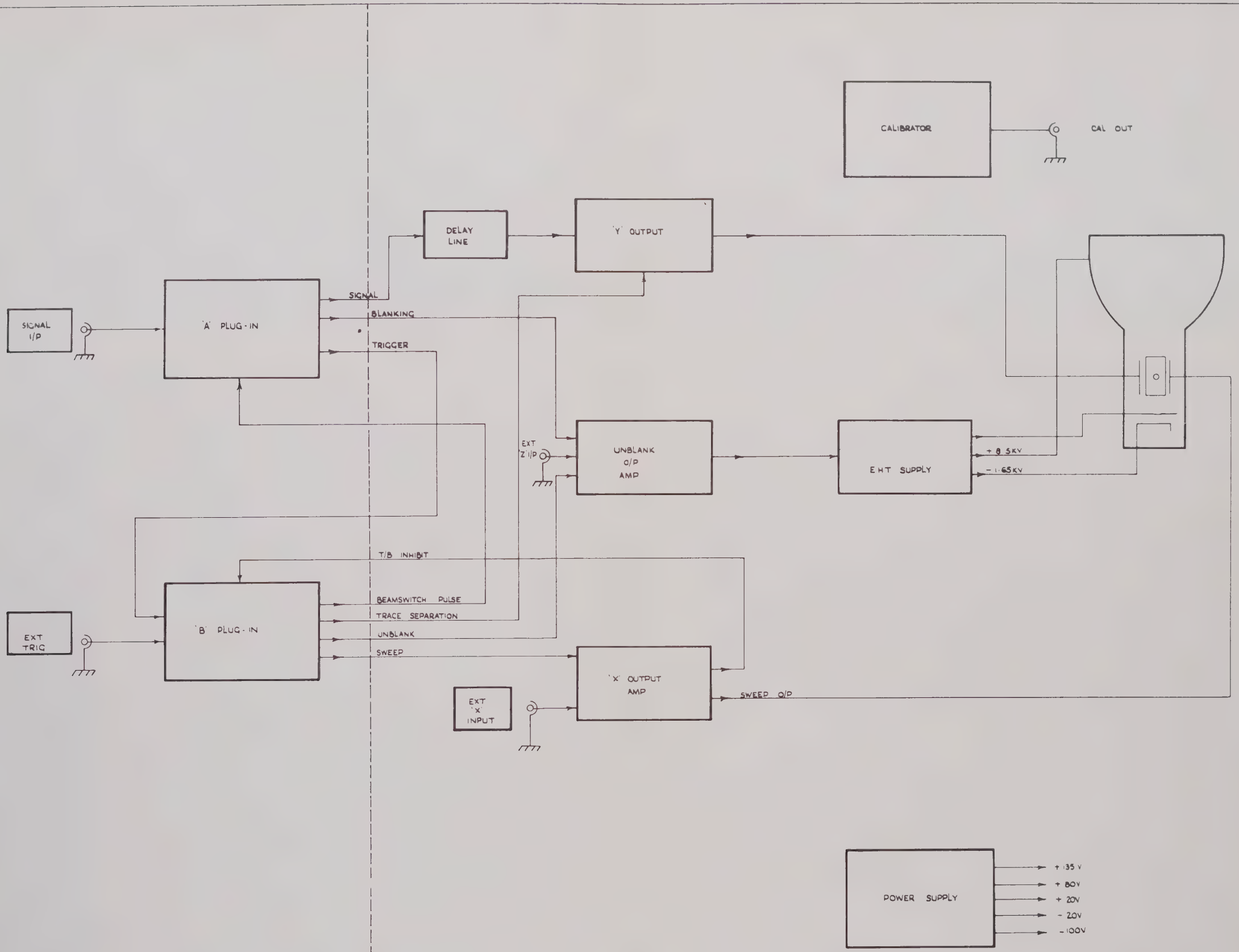
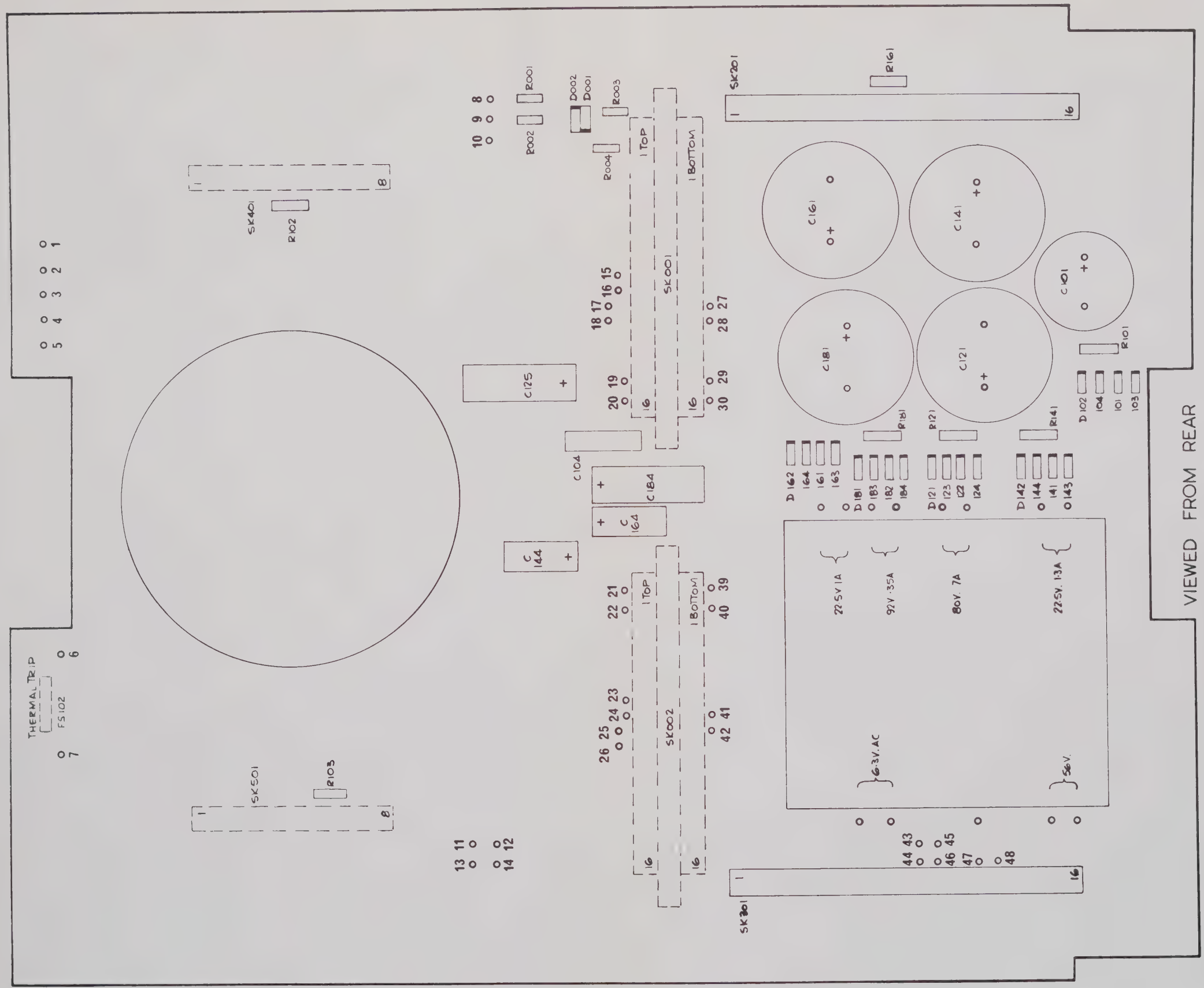


Fig 1. Block Diagram

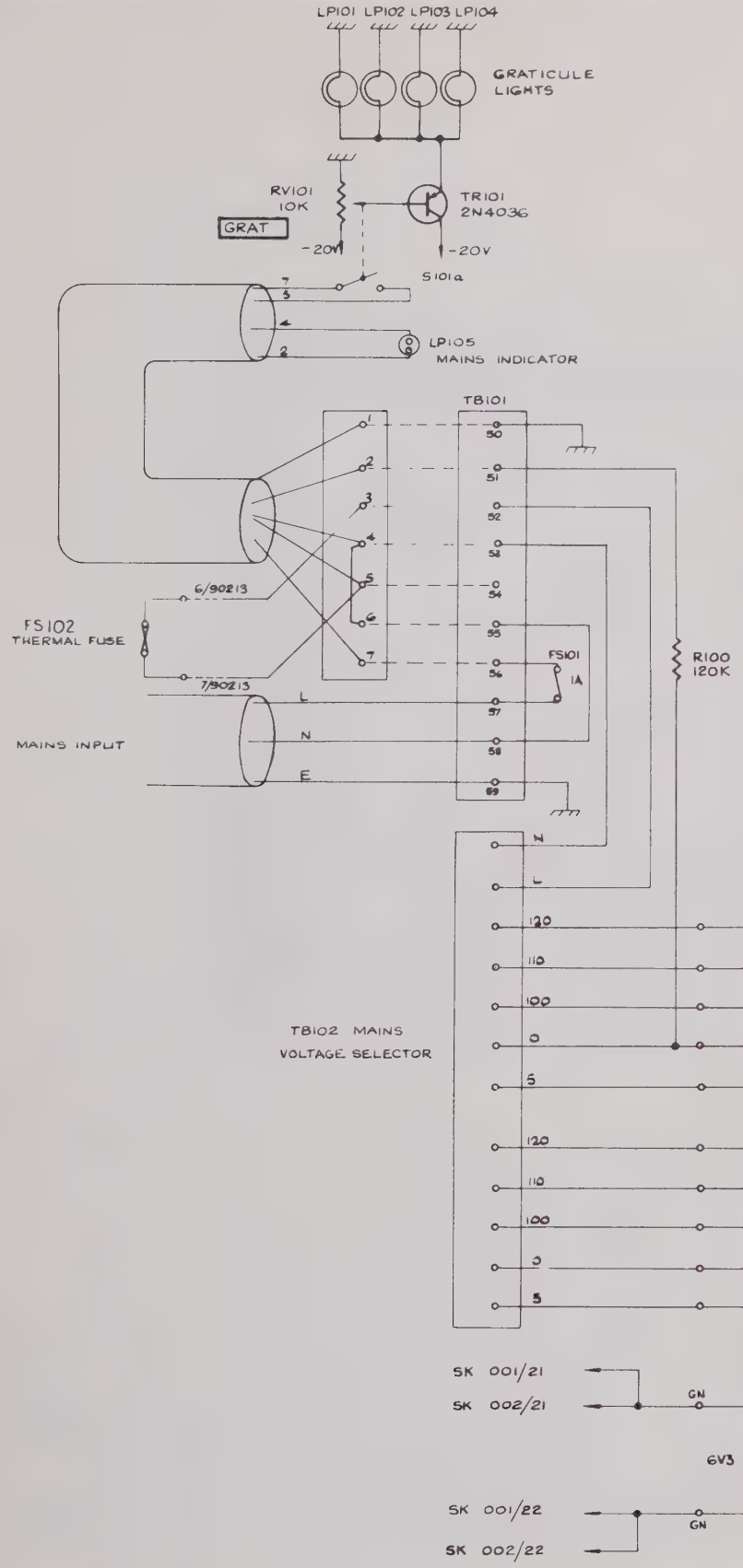


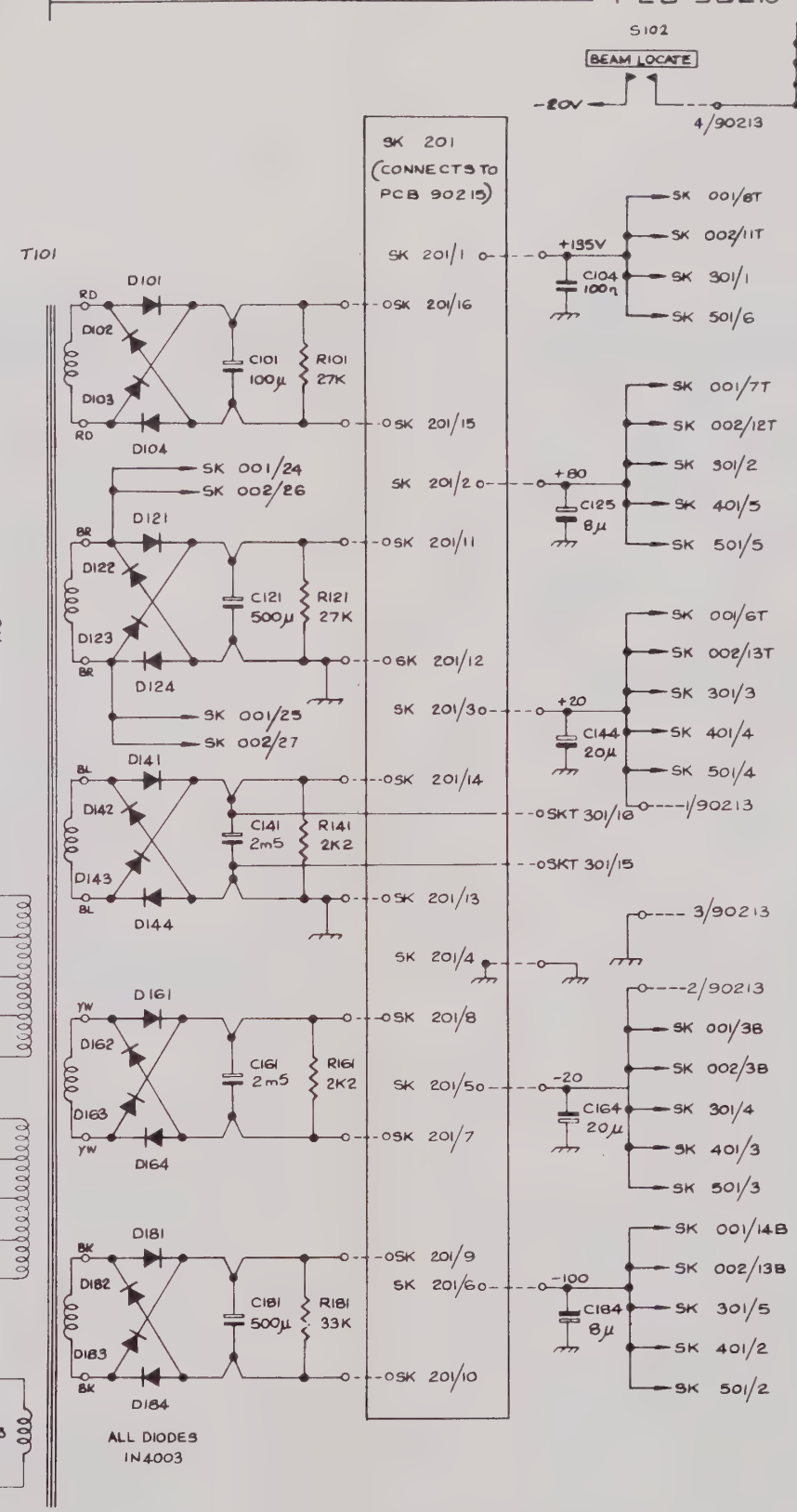
DRWG. No.90213-9 ISSUE 01

Bulkhead Board

M F

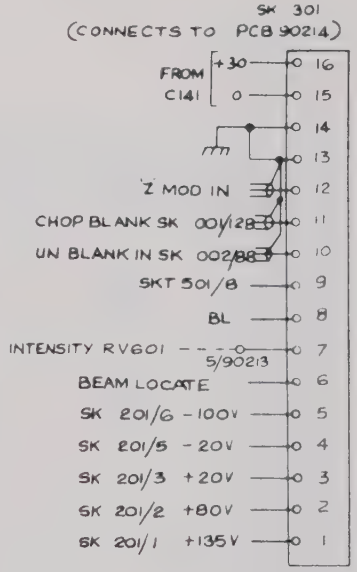
PCB 90213



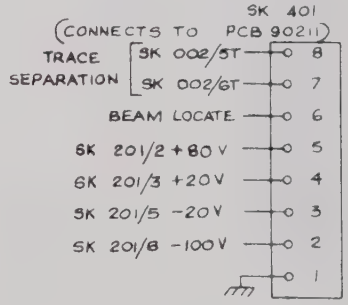


NOTE - PL 301 PIN REFERENCES ARE REVERSED

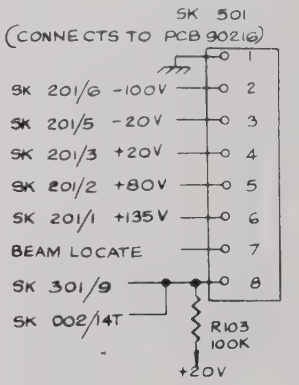
SK 301 (CONNECTS TO PCB 90214)



SK 401 (CONNECTS TO PCB 90211)

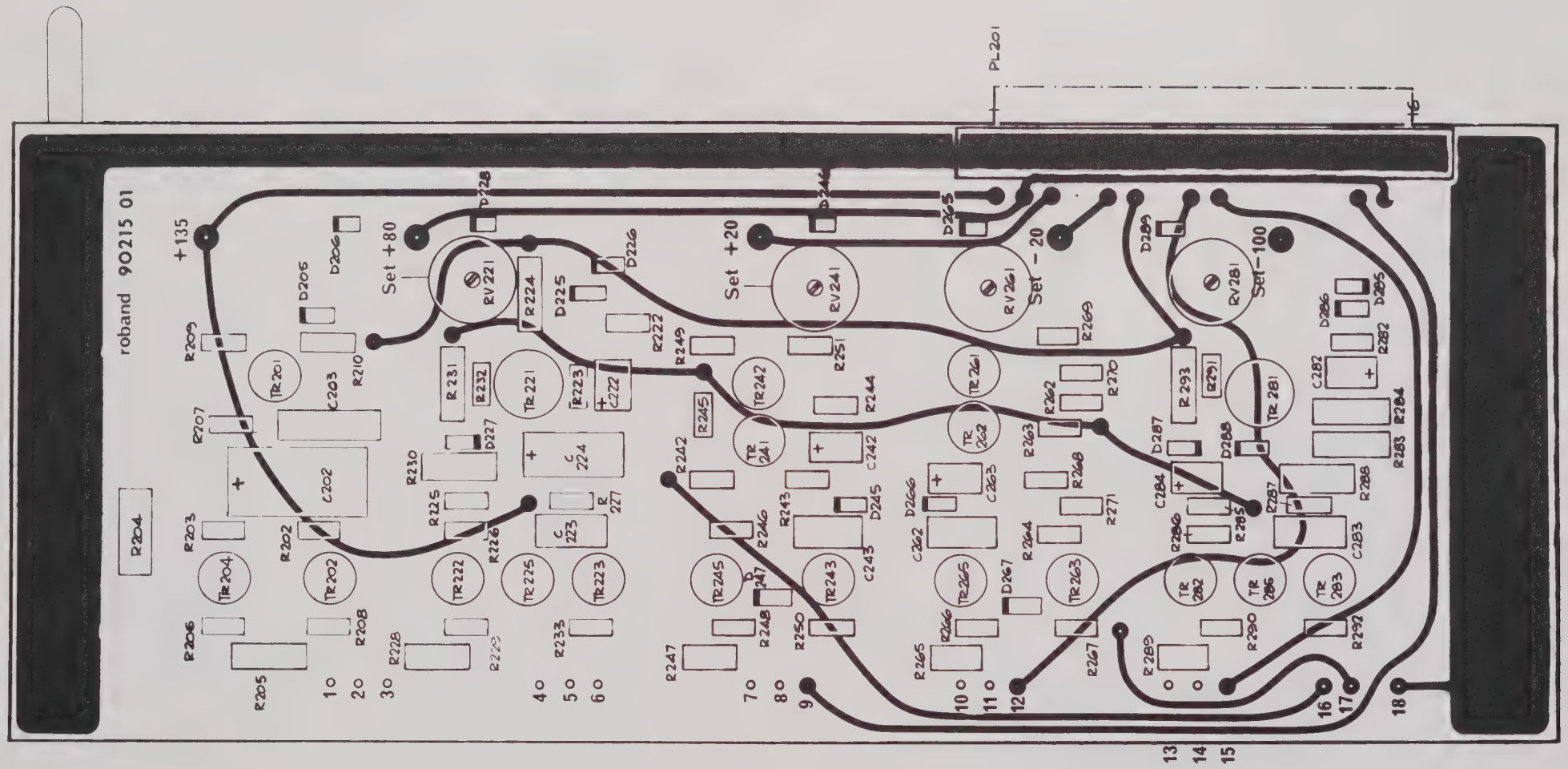


SK 501 (CONNECTS TO PCB 90216)



R070 POWER SUPPLY & DISTRIBUTION CIRCUIT 1

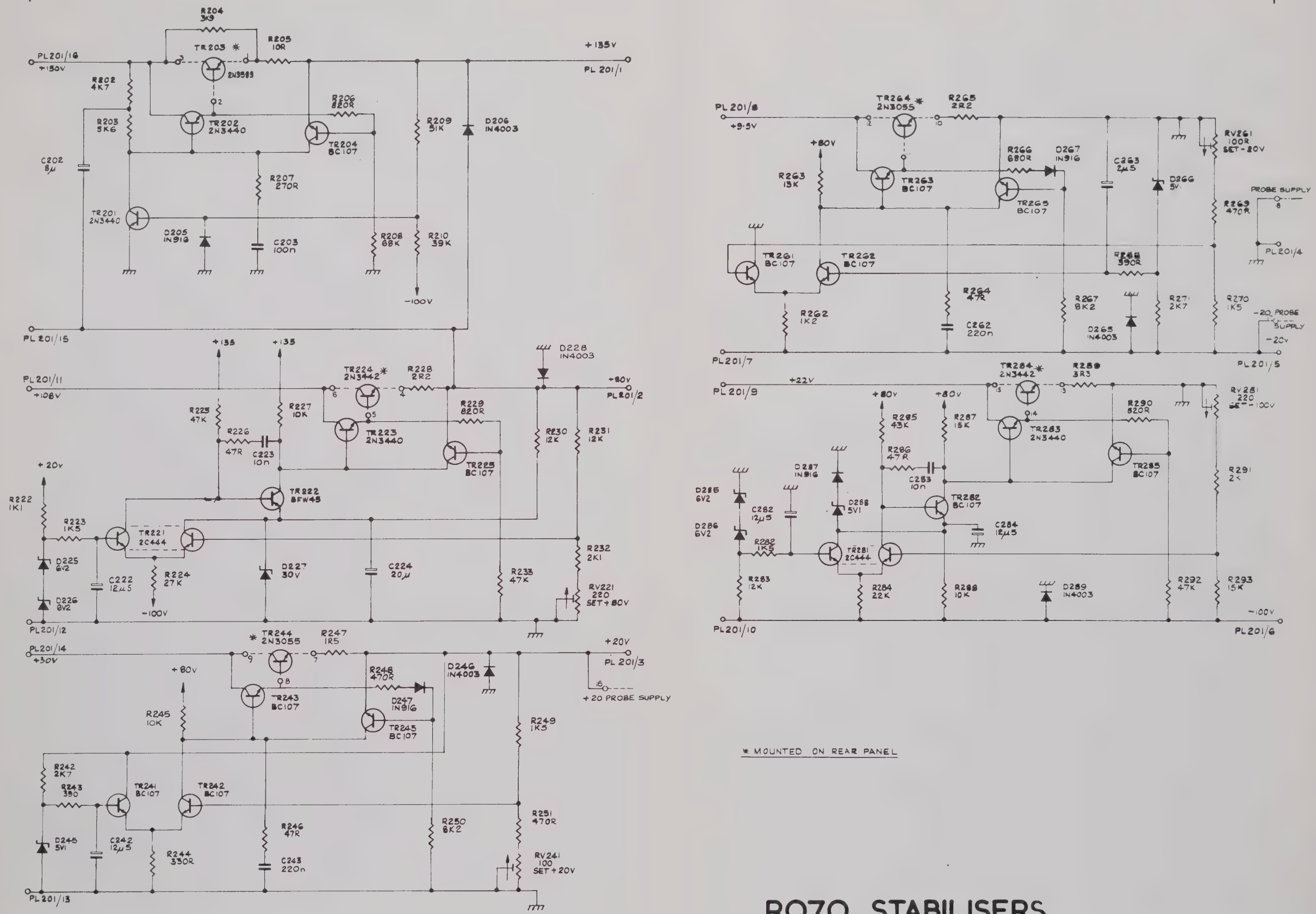
DRWG. No. D9061 ISSUE 01



DRWG. 90215-9 ISSUE 01

Stabiliser Board

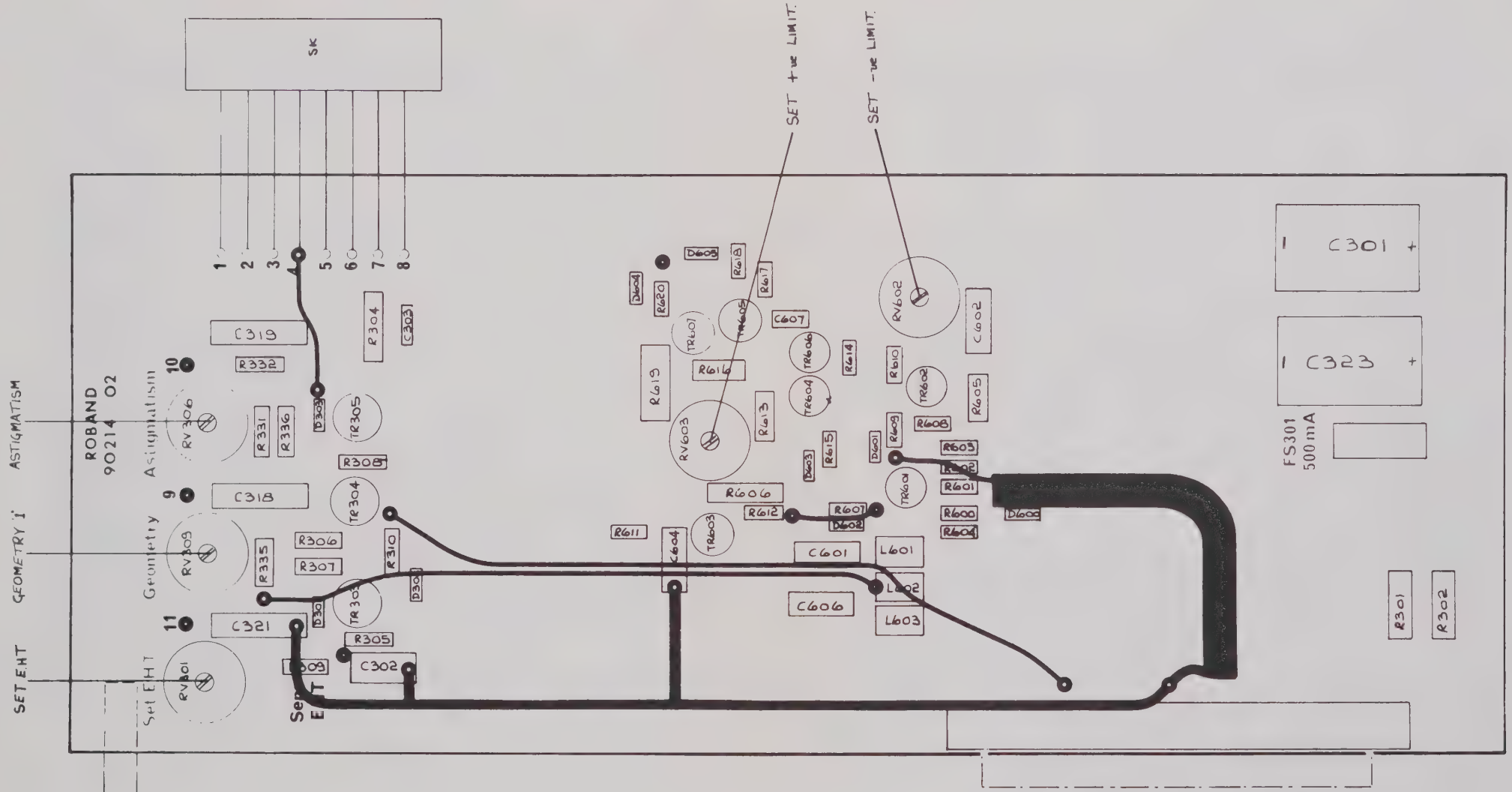
PCB 90215



* MOUNTED ON REAR PANEL

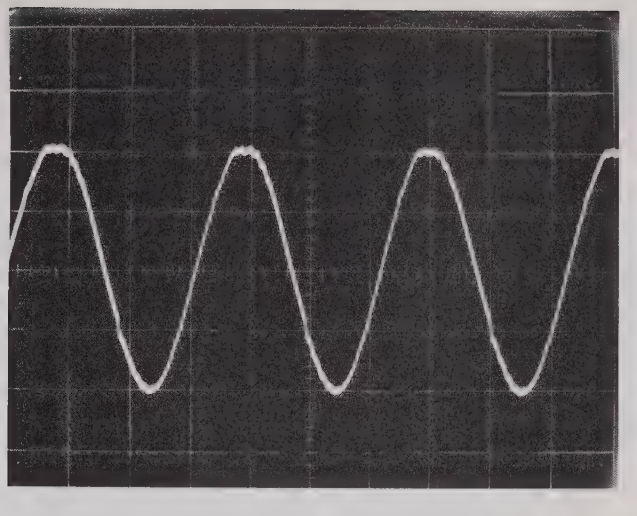
RO70 STABILISERS

CIRCUIT 2 DRWG. No.D9062 ISSUE 01

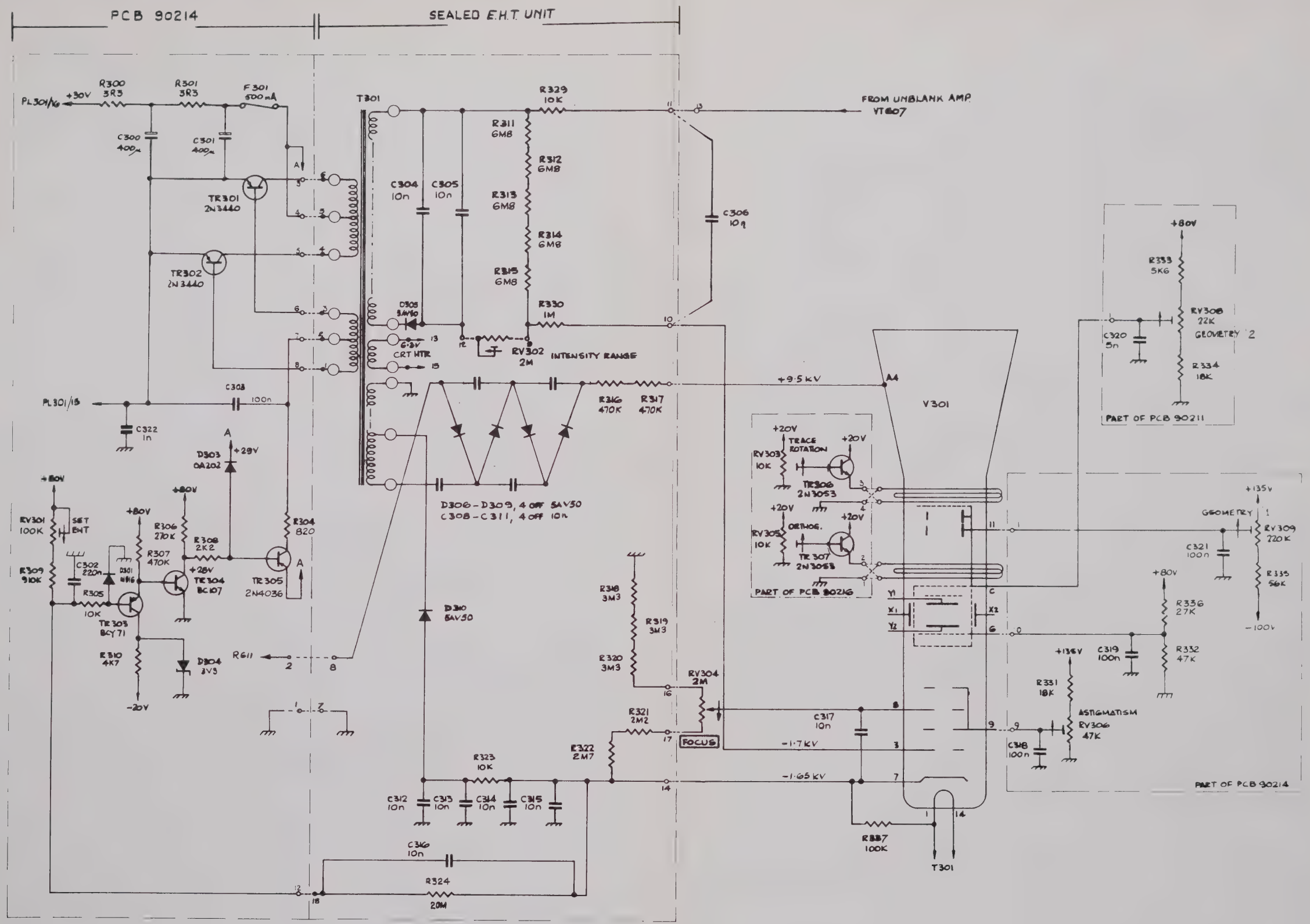


Unblank Amplifier Board

TR302 Collector
10V/cm 10μs/cm



PCB 90214 | SEALED E.H.T. UNIT

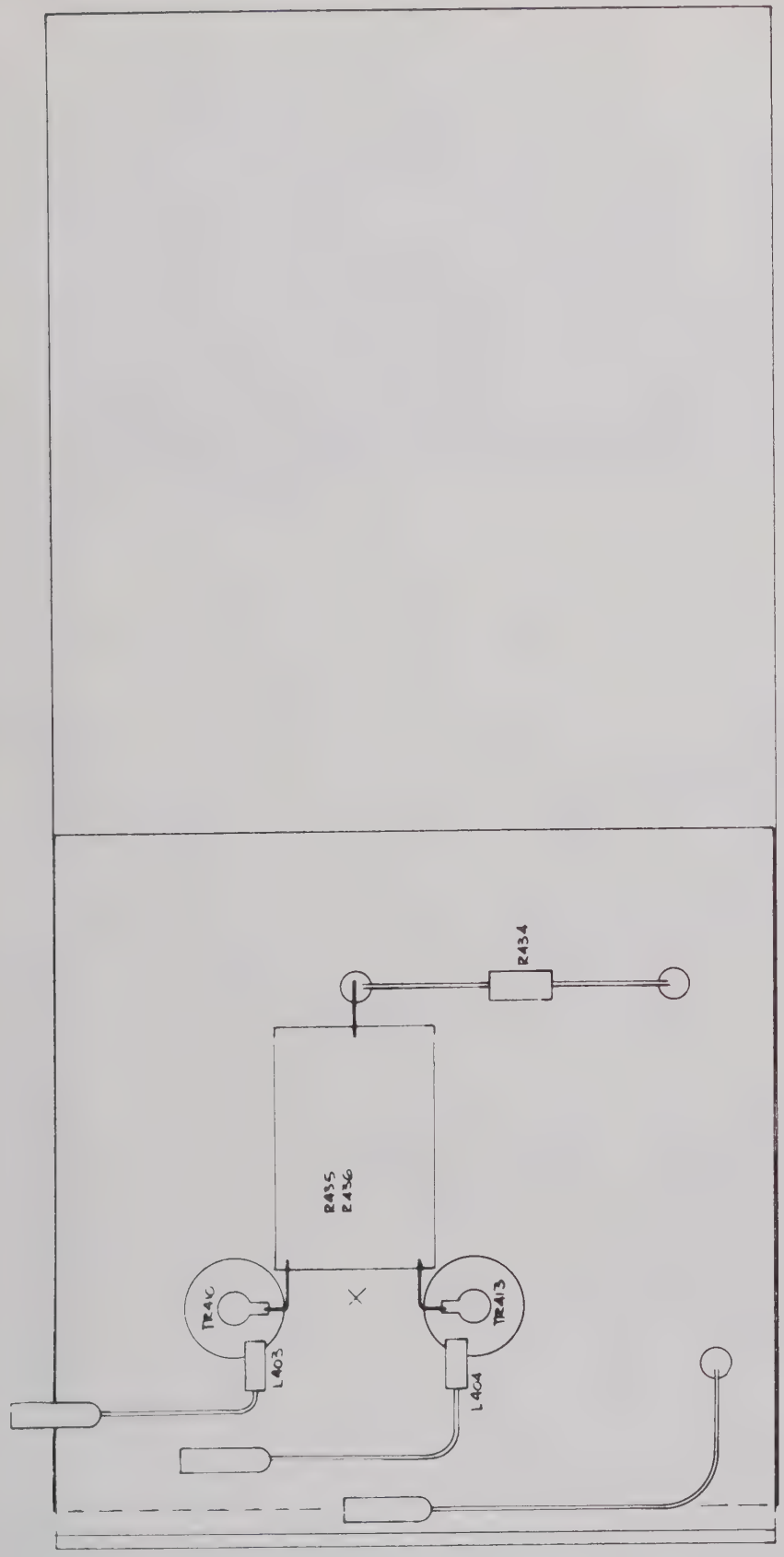


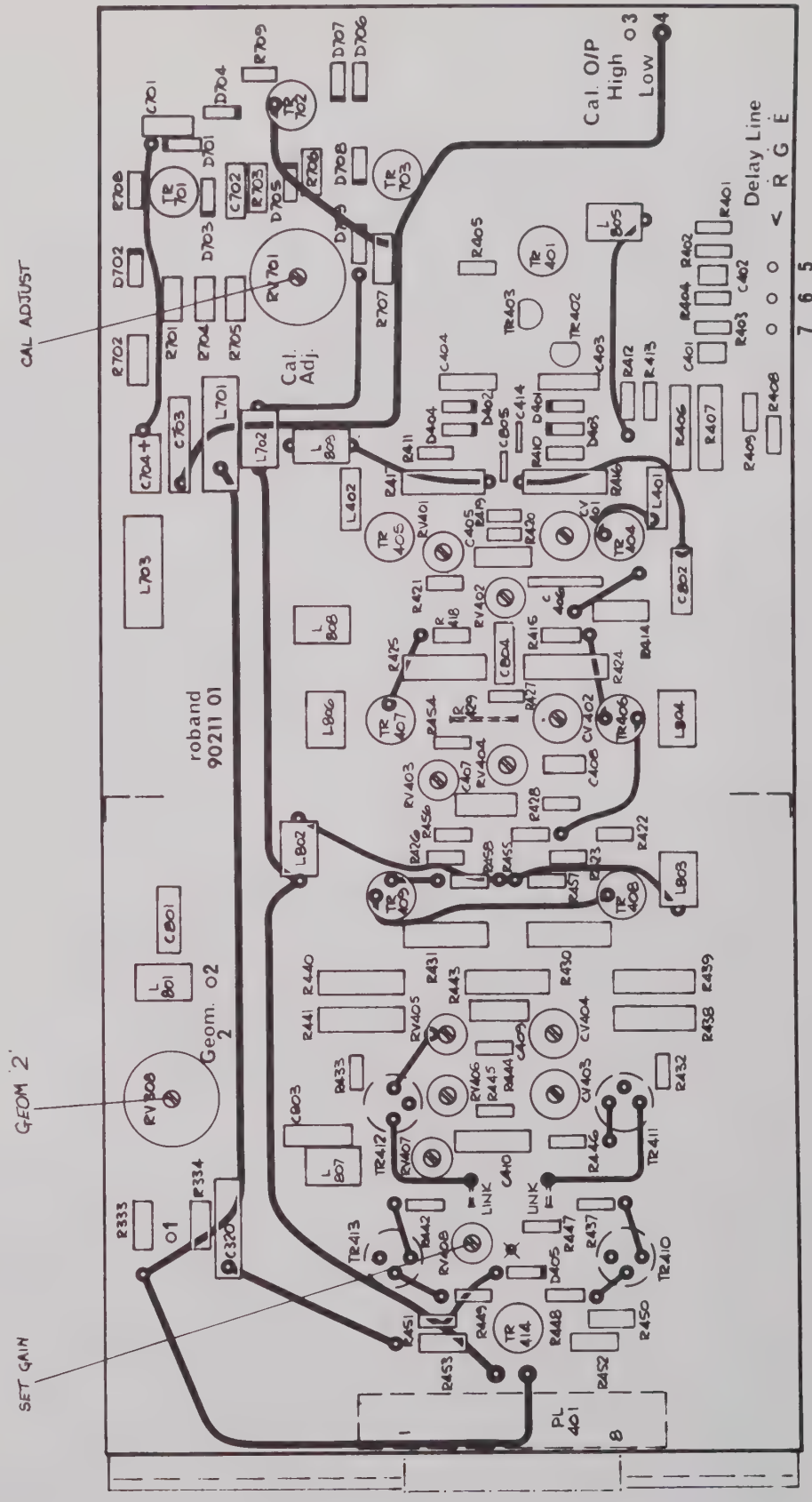
RO70

CATHODE RAY TUBE SUPPLIES

CIRCUIT 3

DRWG. No. D9063 ISSUE 01



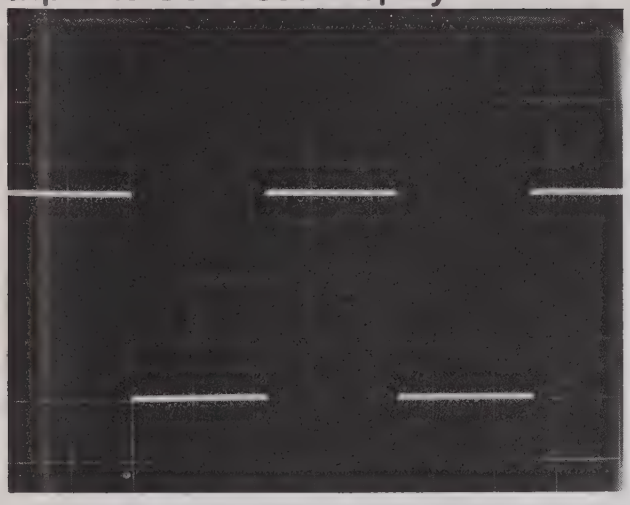


DRWG. No 90211-9 ISSUE 01

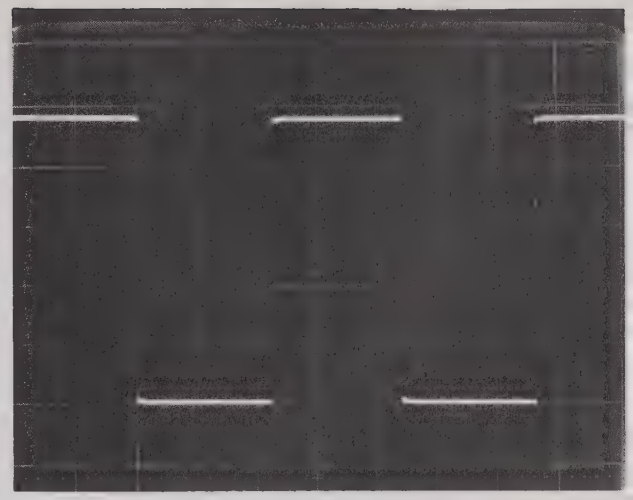
M.E

Vertical Amplifier Layout

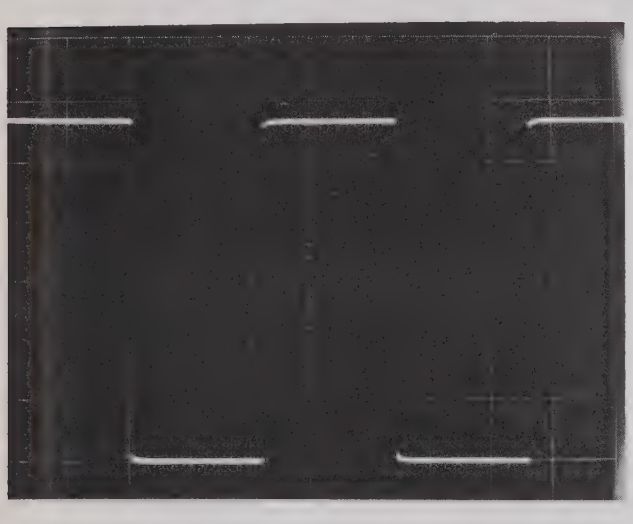
Input is 8cm Cal Display



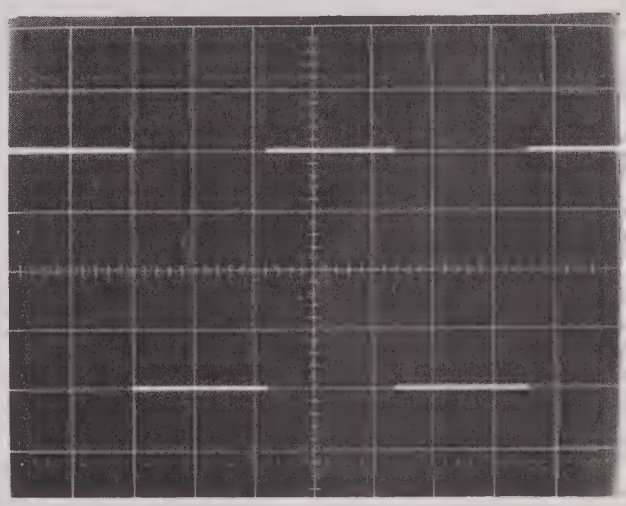
R Input 50mV/cm 200 µs/cm



TR402 Collector 100 mV/cm
209 µs/cm



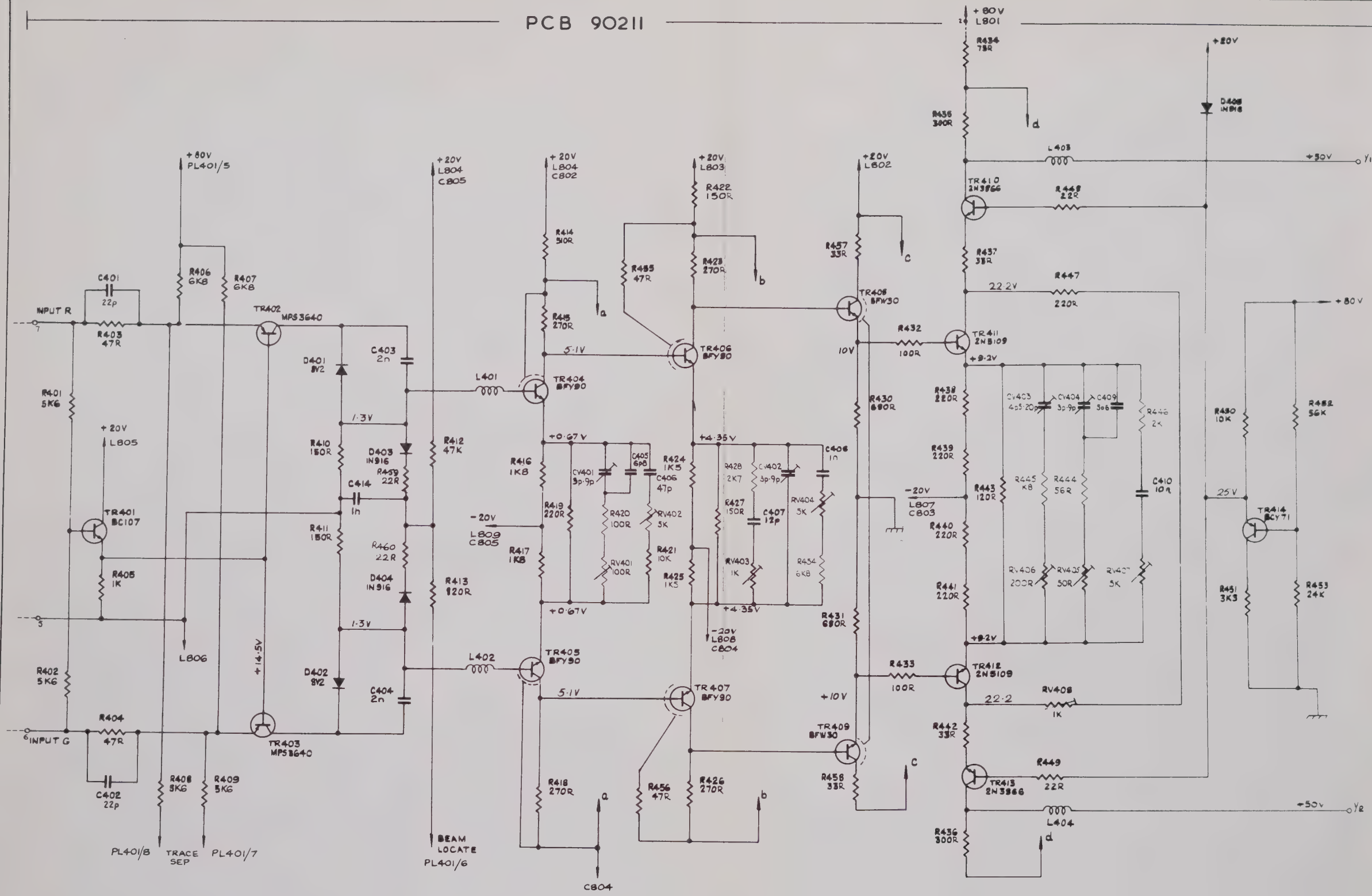
TR404 Collector 299 mV/cm
200 µs/cm



TR406 Collector 1V/cm
200 µs/cm

TR410 Collector 5V/cm
200 µs/cm

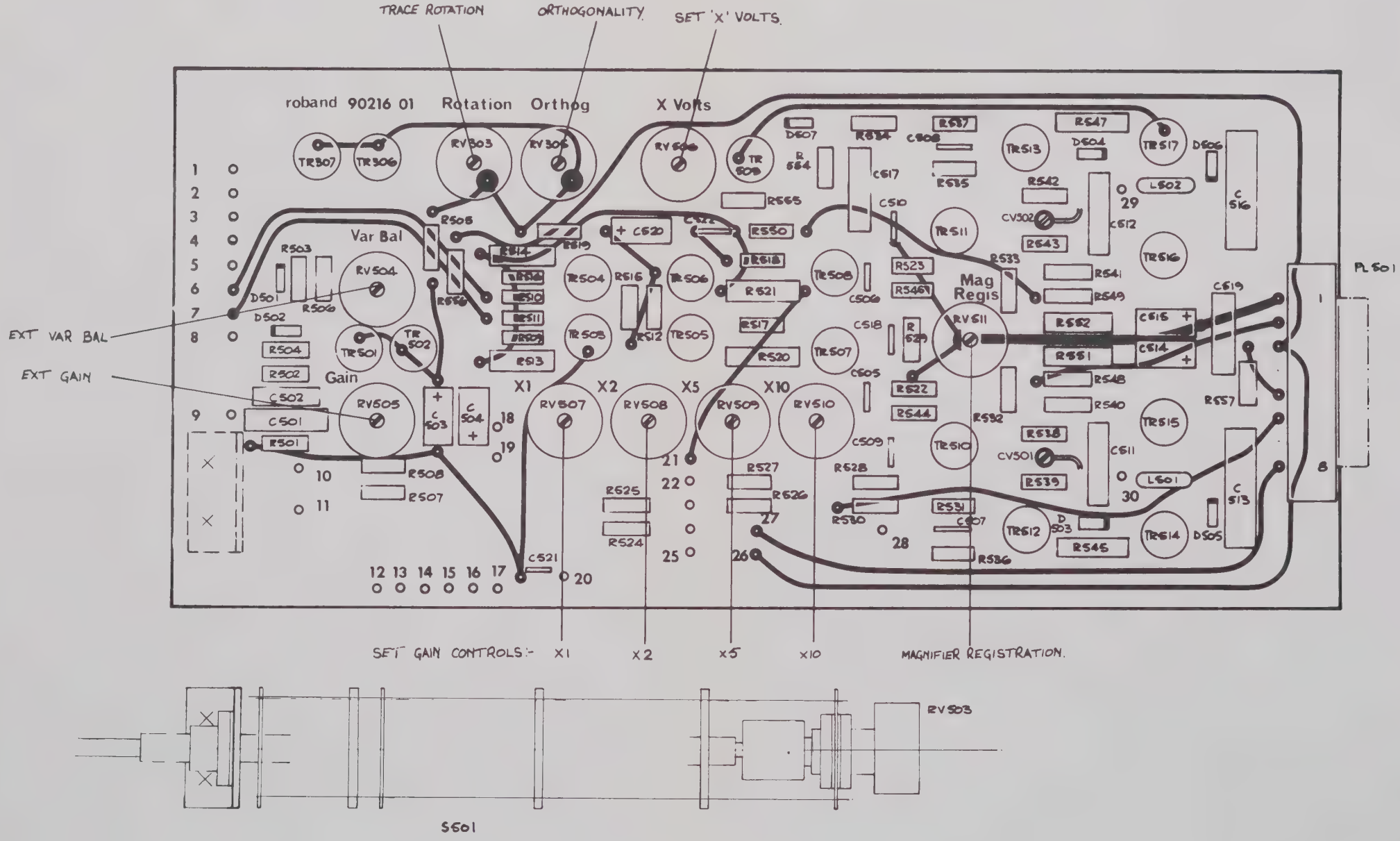
PCB 90211



RO70

VERTICAL O/P AMPLIFIER

CIRCUIT 4 DRWG. No. D9064 ISSUE 01



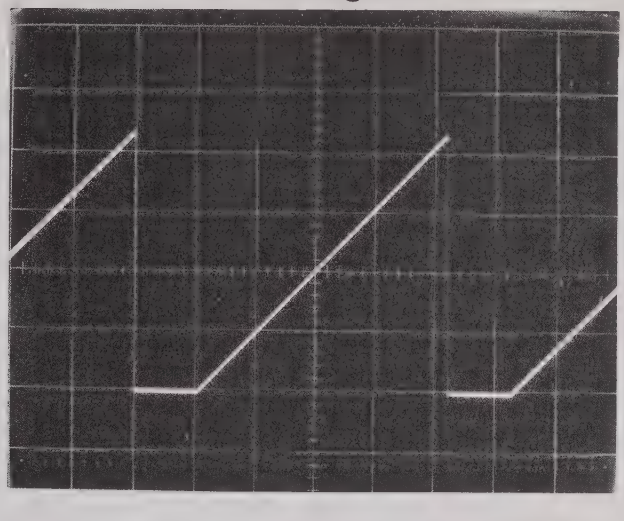
DRWG. No.90216-9 ISSUE 01

MF

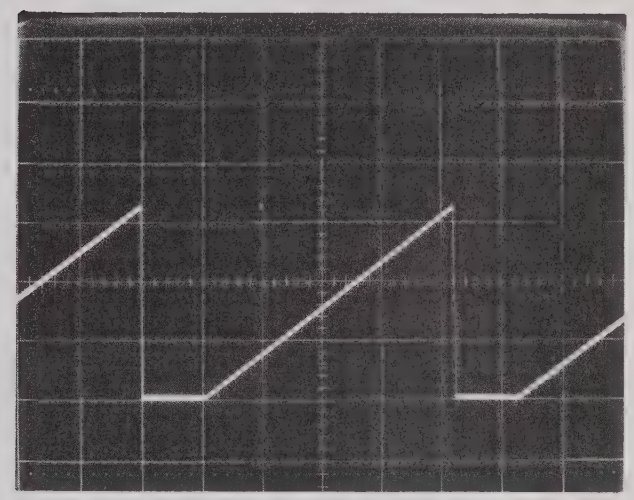
Horizontal Amplifier Board

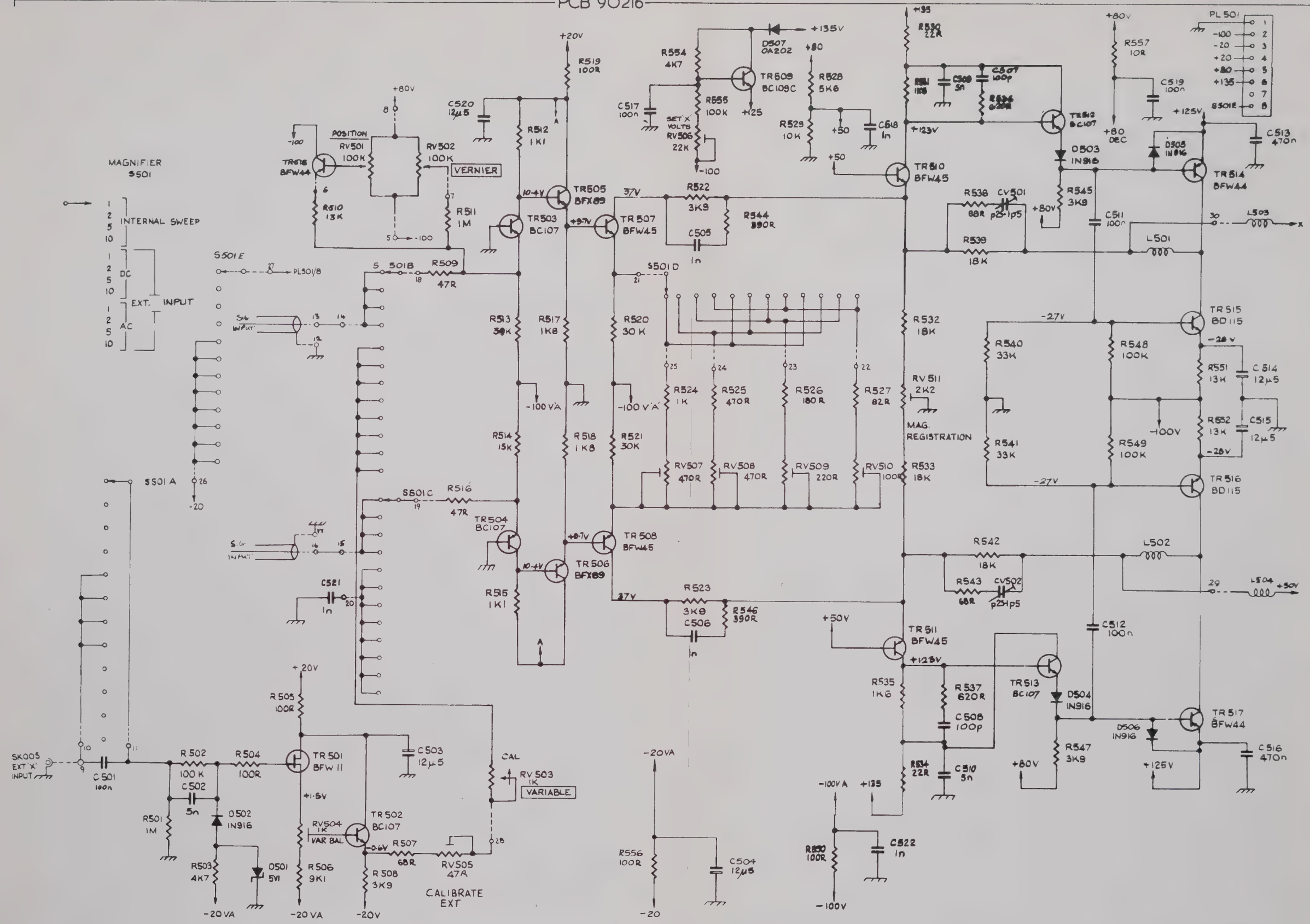
Sweep at 20μs/cm locked to a 1KHz signal

TR514 Collector
20V/cm
500μs/cm



TR505 Emitter
2V/cm
500μs/cm



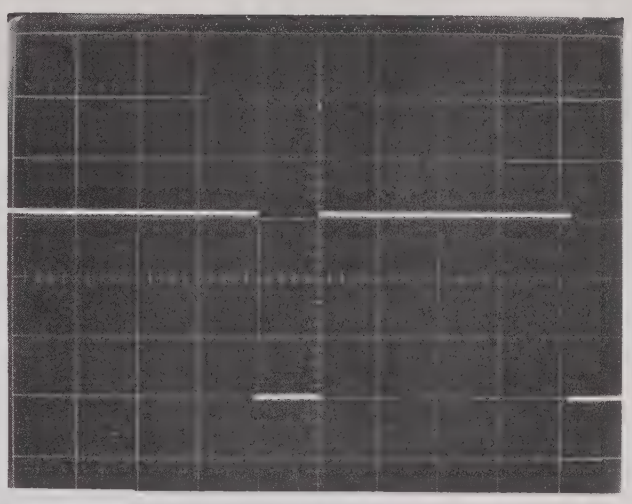


RO70 HORIZONTAL O/P AMPLIFIER

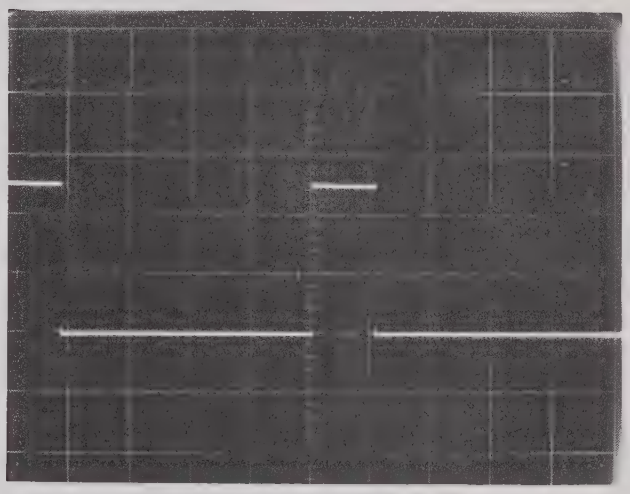
CIRCUIT 5

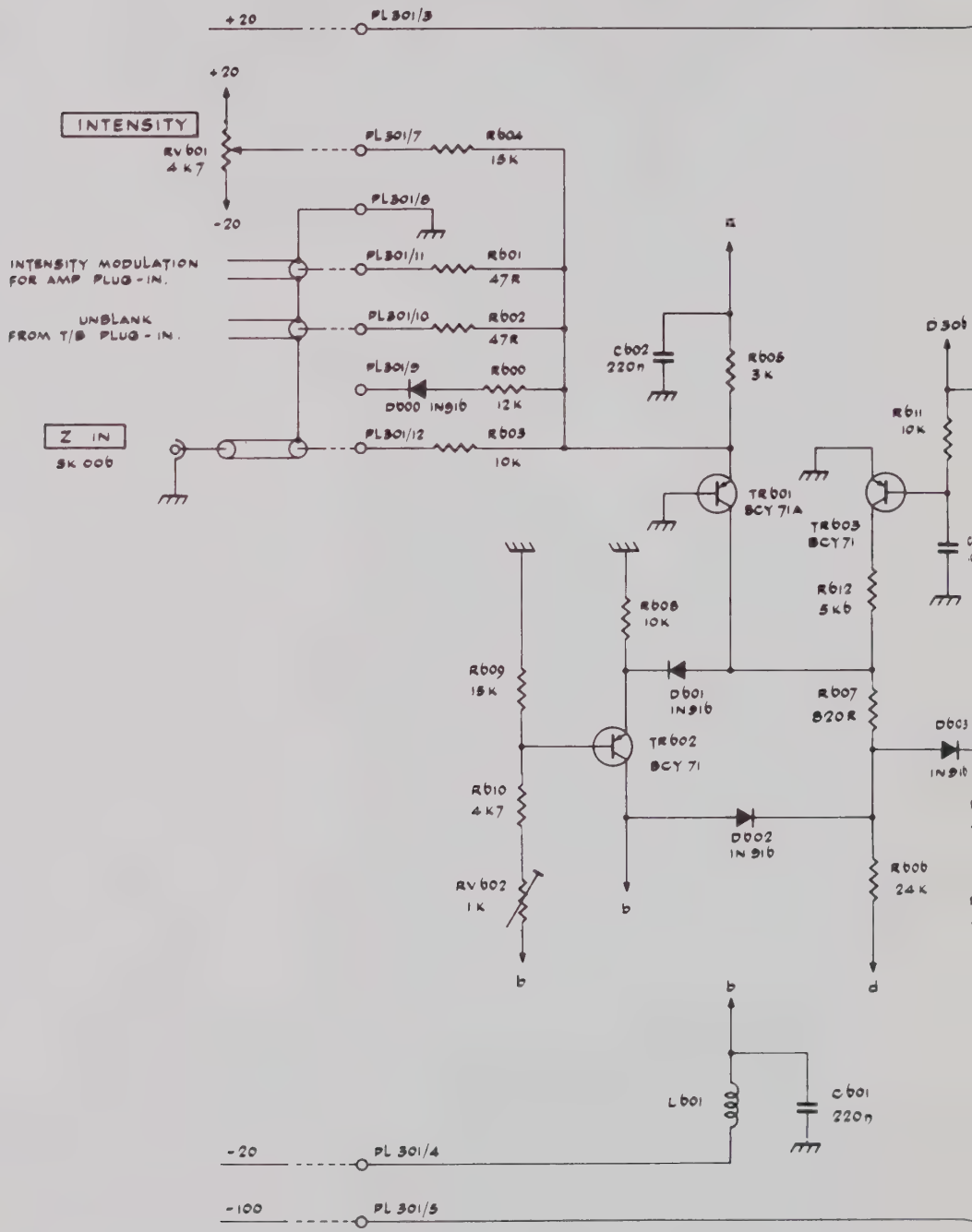
DRWG No. D9065 ISSUE 01

TR607 Emitter
2V/cm 500µs/cm
with intensity
control approx.
⅕ max. Pulse base
line - 18V

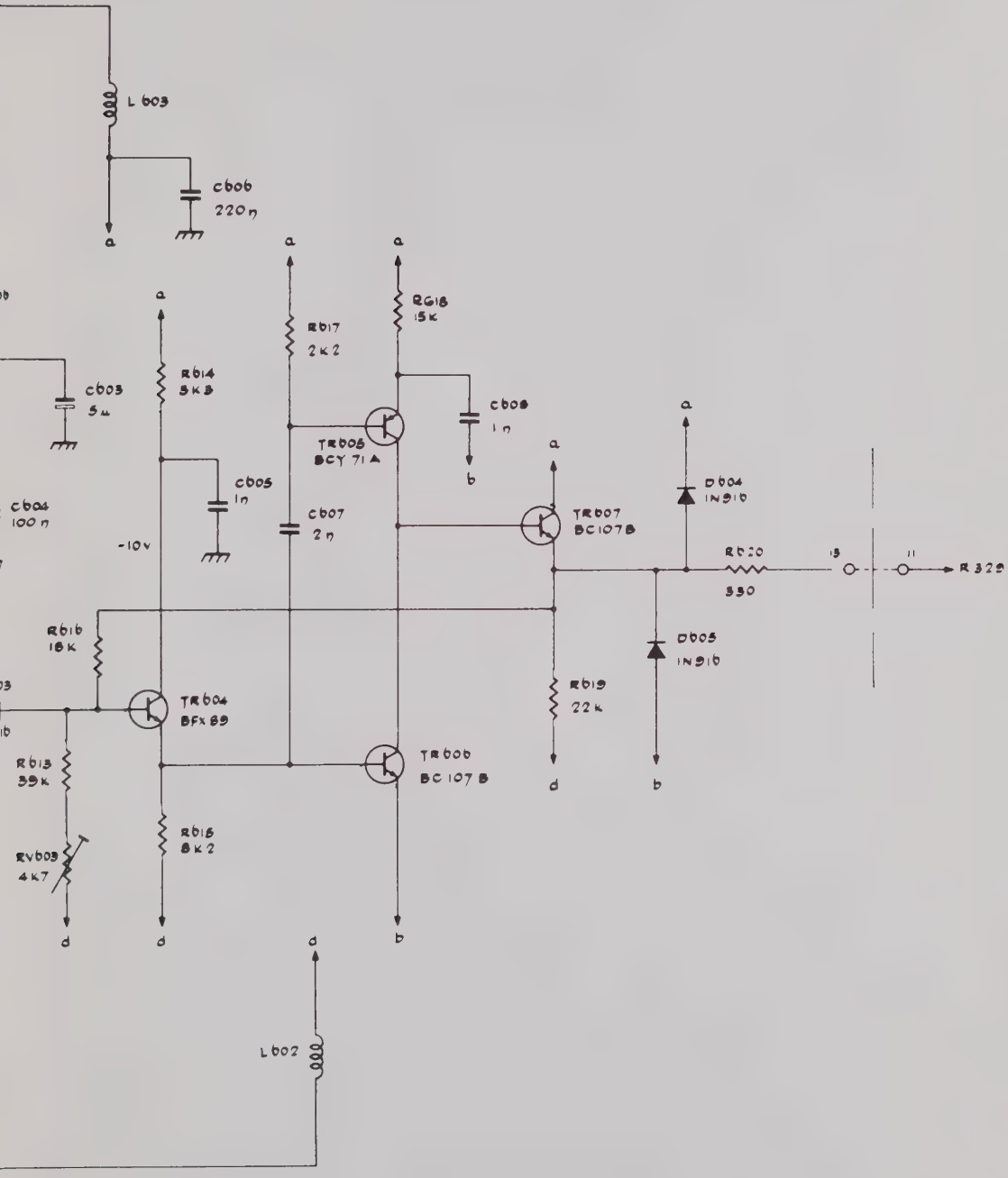


TR601 Collector
1V/cm 500µs/cm
with intensity
control approx.
⅕ max.



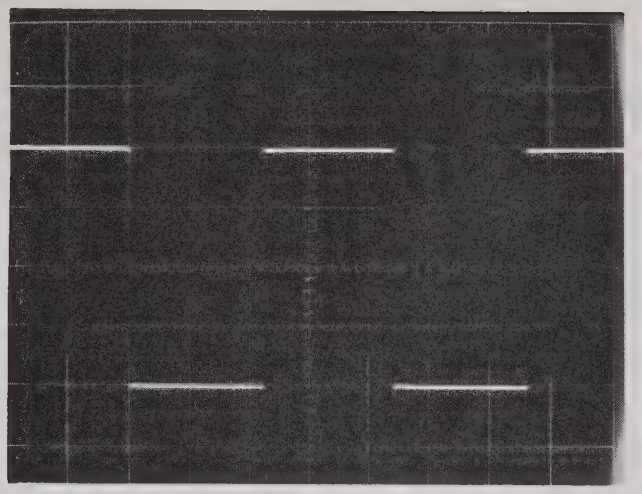

+20
PL301/3
INTENSITY
RV601
4K7
-20
PL301/7
R604
15K
PL301/8
INTENSITY MODULATION
FOR AMP PLUG-IN.
PL301/11
R601
47R
UNBLANK
FROM T/B PLUG-IN.
PL301/10
R602
47R
PL301/9
R600
12K
D600 IN916
Z IN
5K 006
PL301/12
R603
10K
C602
220n
R605
3K
TR601
BCY 71A
TR603
BCY 71
R608
10K
R609
15K
D601
IN916
R612
5K6
R607
820R
TR602
BCY 71
R610
4K7
D602
IN 916
RV602
1K
R606
24K
L601
C601
220n
-20
PL 301/4
-100
PL 301/5

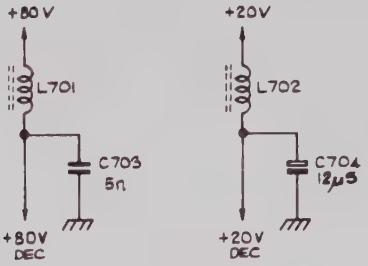
P C.B. 90214

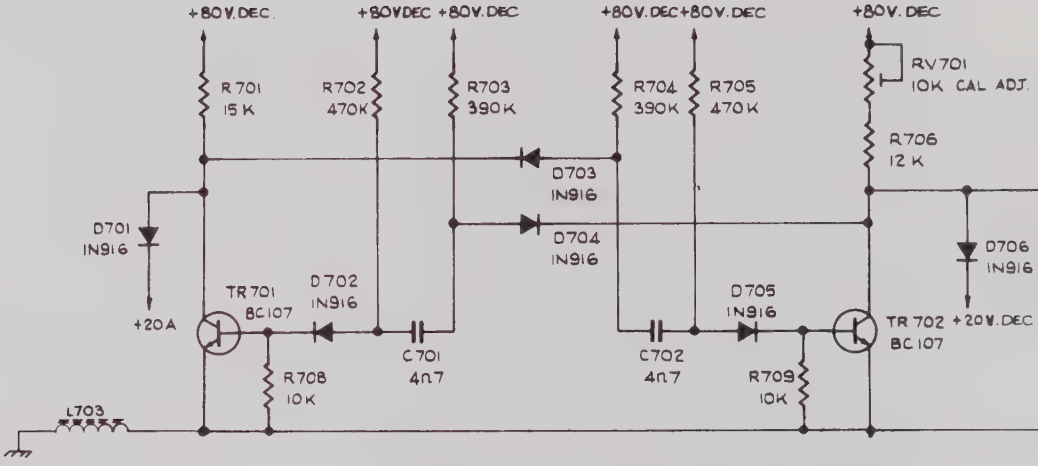


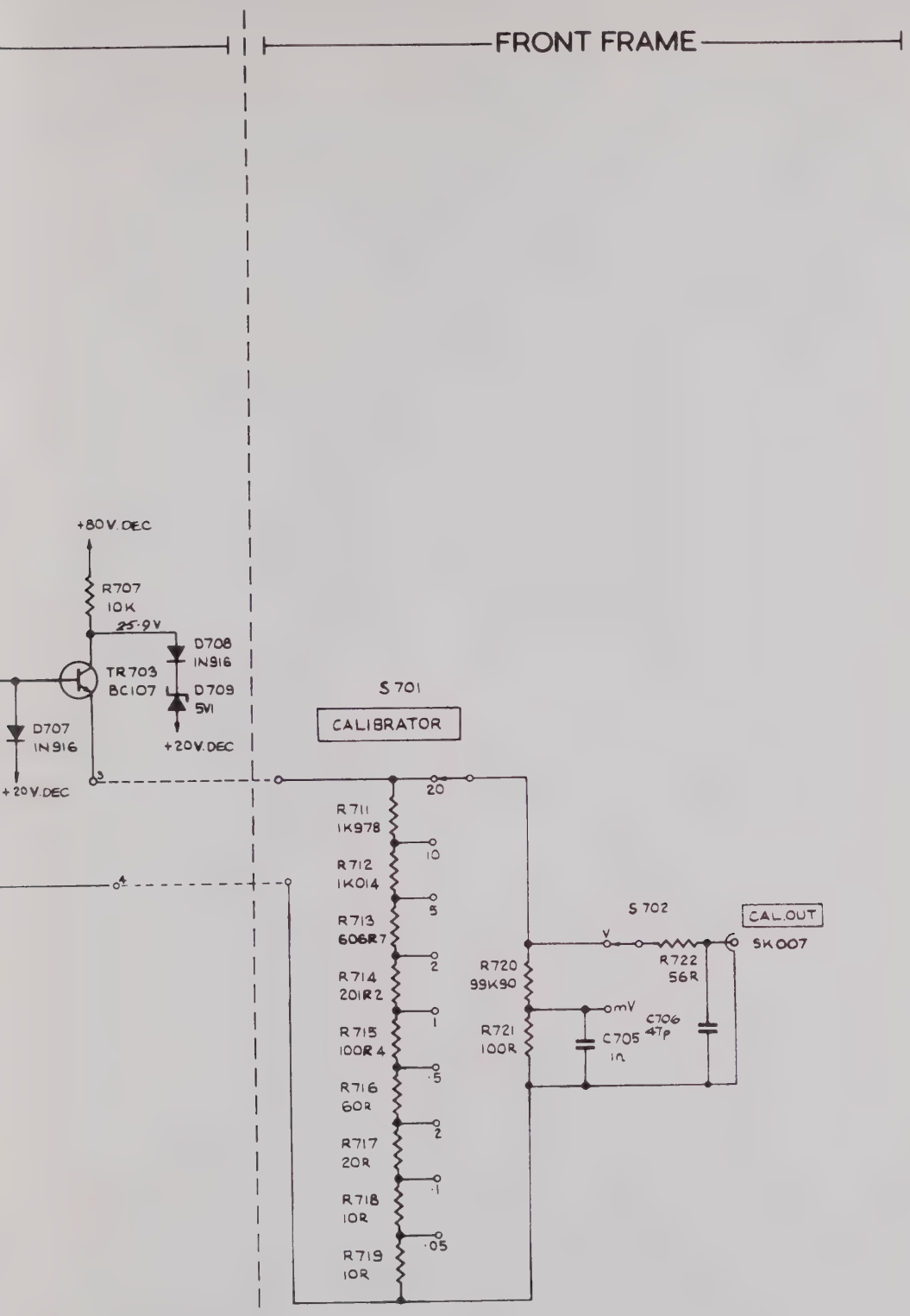
RO70 UNBLANK AMPLIFIER CIRCUIT 6. DRAWING No. D9066 ISSUE 02

200mV
Cal Output
50mV/cm
200μs/cm




+80V
L701
C703
5n
+80V
DEC
+20V
L702
C704
12μS
+20V
DEC

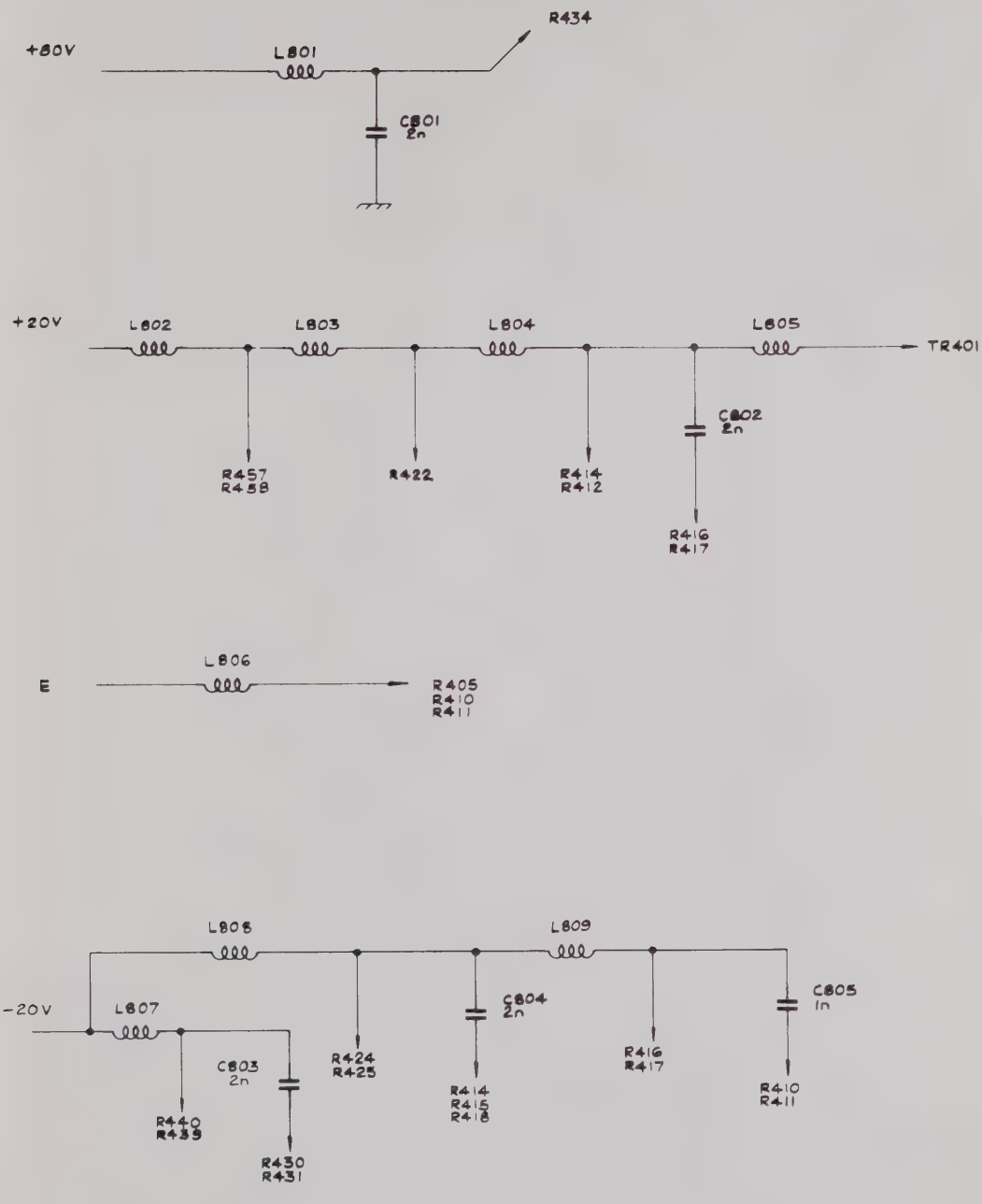

+80V.DEC.
+80VDEC
+80V.DEC
+80V.DEC
+80V.DEC
+80V. DEC
R701
15K
R702
470K
R703
390K
R704
390K
R705
470K
RV701
10K CAL ADJ.
R706
12K
D703
IN916
D704
IN916
D701
IN916
D706
IN916
+20A
TR701
BC107
D702
IN916
C701
4n7
C702
4n7
D705
IN916
TR702
BC107
+20V.DEC
R708
10K
R709
10K
L703



RO70 CALIBRATOR

CIRCUIT 7

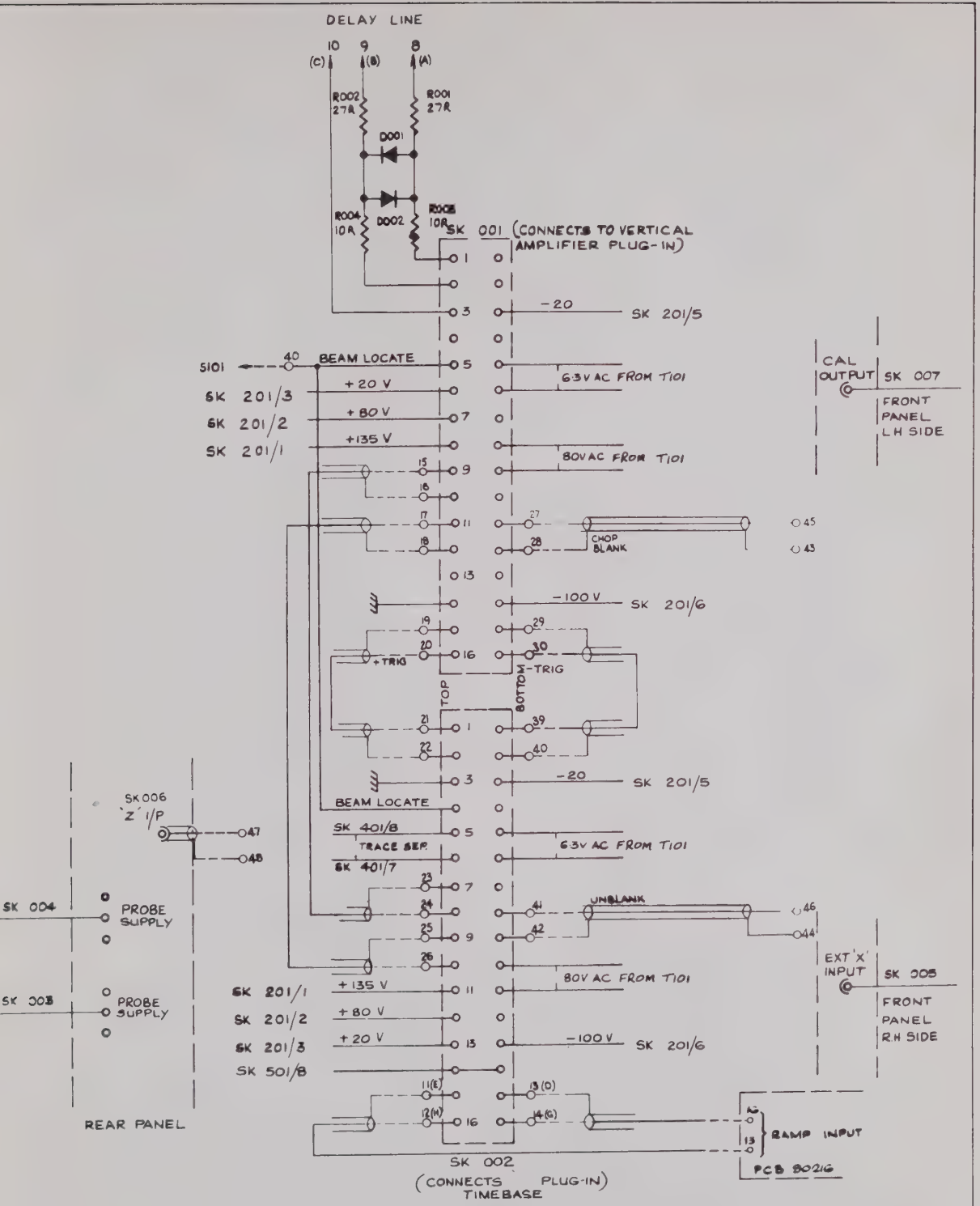
DRWG. No D9067 ISSUE 01



R070 VERT. AMP. HT DECOUPLING

CIRCUIT 8

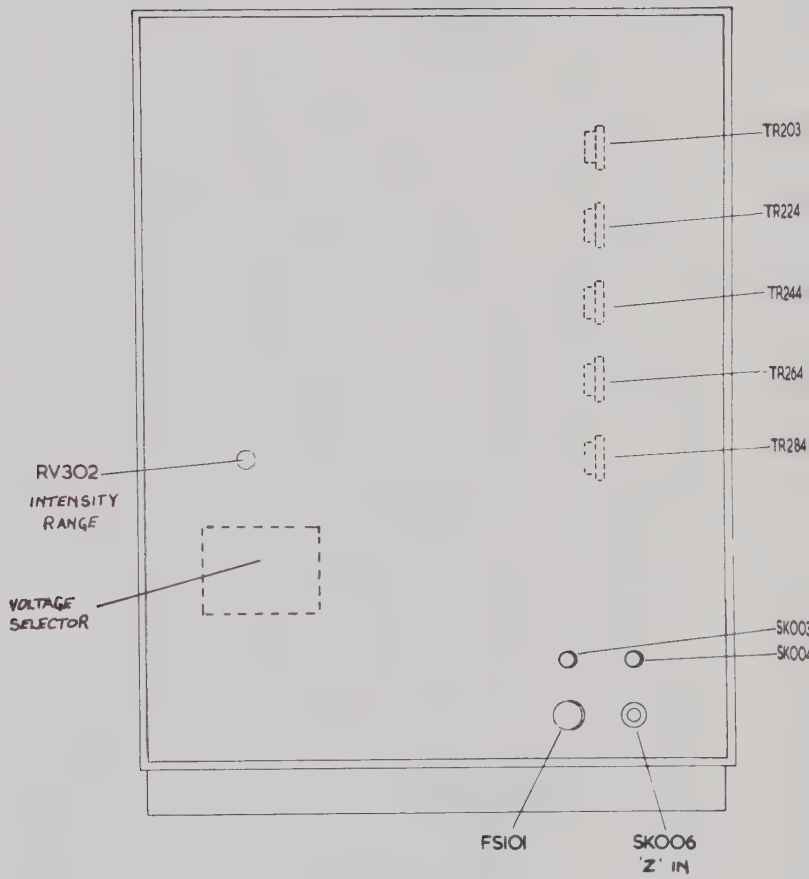
. DRWG. No. 9068 ISSUE 01



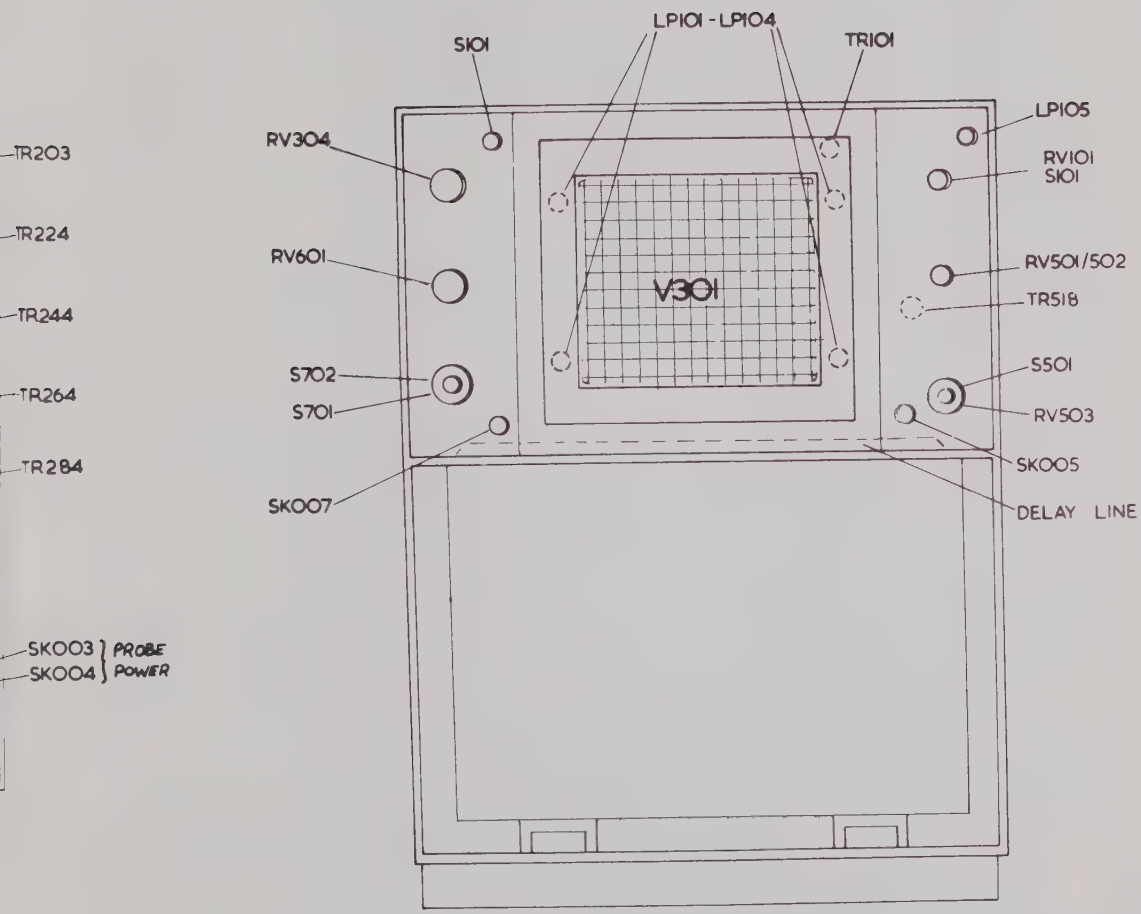
PINS ON LEFT HAND SIDE OF SK002 MARKED 'T' ON CIRCUIT IS ARE AT TOP ON BULKHEAD BOARD PINS ON RIGHT HAND SIDE MARKED 'B' ARE AT BOTTOM

R070 INTERFACE SKT. LAYOUT.

CIRCUIT O DRWG. No. D9040. ISSUE 01

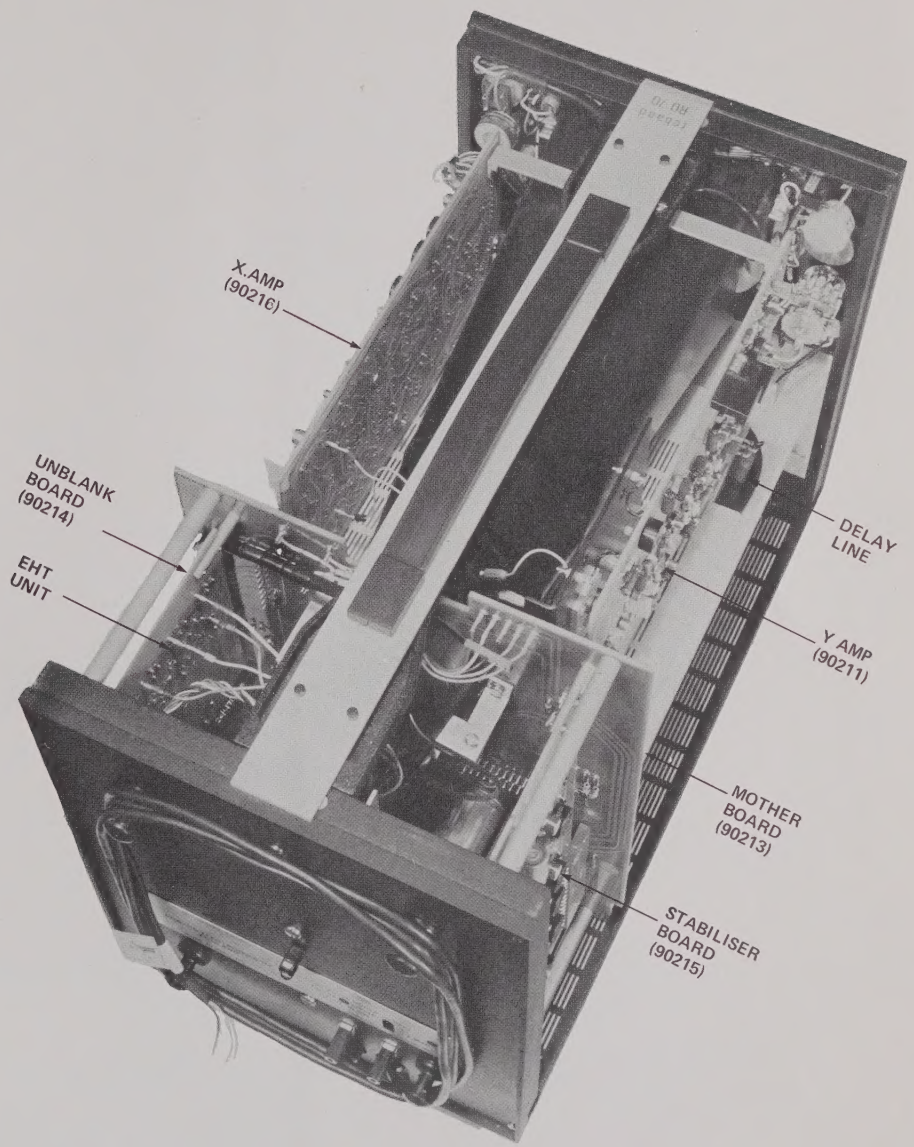


REAR PANEL & COVER LAYOUT



FRONT PANEL LAYOUT

FIG 2


X.AMP
(90216)
UNBLANK
BOARD
(90214)
EHT
UNIT
DELAY
LINE
Y AMP
(90211)
MOTHER
BOARD
(90213)
STABILISER
BOARD
(90215)

MP MASTER
MA24166